The Himalayan Gazetteer or

The Himalayan Districts of the North Western Province of India

In 3 Vols. (6 Parts)

Edwin T Atkinson

Vol. 1 in 2 parts

Part - 1

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PREFACE.

The system of transliteration used in the present volume is that which has been adopted in the Gazetteer of the North-Western Provinces. For the vowels it is briefly as follows :—

a	as in	'woman.'	u	as in	'pull.'
á	"	'father.'	ú	"	'rule.'
e	"	'grey.'	ai	"	'aisle.'
i	"	'bit.'	o	"	'hole.'
í	"	'machine."	au	as	'ou' in 'house' (nearly).

The original plan of this Memoir provided for a thorough examination of the country between the Tons and the Káli somewhat on the plan of Tennent's Ceylon, and in addition a less detailed summary of our knowledge of the Himálaya-Tibetan region. It was believed that only thus could the physical unity and with it the historical connections of the entire region be correctly understood. From or through the Himálaya came the pre-Aryan and Aryan races now inhabiting India, as well as the successive waves of Baktrian, Skythian, and Musalmán invaders who have conquered India in historical times. As we shall see hereafter, forms of belief having their origin in or beyond the Himálaya have influenced the religious systems of India from the earliest ages to the present day, so that for the political and religious history of the plains an adequate conception of the physiography, ethnography, nd history of the Himálaya-Tibetan tract is a necessary preparaion. It is to be regretted that this extended programme cannot e carried out, but the pressure of official duties prevents its comletion, and all that can now be attempted is to work up the mateals that have been collected for the Himálayan districts of the orth-Western Provinces. At the end of Chapter I. will be found series of 'References' to materials illustrating the history and sources of the Himálaya from Asám to Afghánistán. These were llected in continuation of a plan suggested by Mr. R. N. Cust in 866 for the preparation of a 'Catalogue raisonné of every kind of rinted information connected with the North-Western Provinces;' d I certainly know of no better aid to good administration than index to the special and local reports of those engaged in it. he necessity for such a catalogue has ceased in great part wtih the publication of the District Memoirs, but there are subjects of general importance which the publication of the local accounts does not subserve. One of these is the history, using this word in its widest sense, of the Himálaya-Tibetan region, and I offer the references as the nucleus of a complete index to our knowledge of its physiography, products, peoples, and institutions.

As observed in the foot-note to Chapter I., much remains to be done, but at the same time very much more has been accomplished than is generally known. Scientific and economic botany have been carefully explored; the chapter on economic mineralogy leaves little to be desired: those on meteorology and geology have been brought up to the level of our present scientific knowledge; and the introduction to physical geography gives a popular and suggestive summary of the information that we possess, whilst the references afford a guide to materials for the study of details. All this is new, or embodies information buried in correspondence and reports, and practically as inaccessible to the public as if it had never been committed to writing. To General Richard Strachey I am indebted for the use of an unpublished work of his own on the physical geography of the Himálaya, which has been specially made use of in the chapters on 'Geology' and 'Meteorology.' Mr. H. B. Medlicott, Superintendent of the Geological Survey of India, prepared the chapter on 'Geology,' and Mr. S. A. Hill, Meteorological Reporter to the Government of the North-Western Provinces, contributed the valuable chapter on 'Meteorology.' Dr. King, Superintendent of the Royal Botanical Gardens, Calcutta, furnished the list of the *flora* of Western Garhwál, Dehra Dún, and Jaunsár-Báwar, and Dr. Watson, the list for Eastern Garhwál, Kumaon, and the Bhábar. To General Strachey I am further indebted for the list of plants collected by himself and Mr. Winterbottom in Kumaon, Garhwál, and the neighbouring parts of Tibet, and which has never before been published. This list has been admirably edited by Mr. F. Duthie, Superintendent of the Botanical Gardens at Saháranpur, to whom also I am indebted for the sketch of the history of the Tea industry in the Himálayan districts. The sheets of the portions relating to economic botany have had the criticism of Dr. Watson and Mr. Duthie; and for the forest history Mr. Greig and Major Garstin have advised me in many matters of detail.

Of the maps, the map of Kumaon was prepared under the instructions of Colonel Walker, R.E., Superintendent of the Great Trigonometrical Survey, and is the result of great labour and care for detail: indeed, a less accurate map might possibly be more useful. The great 'one-inch to one-mile' sheets were photographed down to a smaller scale and sent to me. I then obtained the correct names in Hindi of all the villages, rivers, &c., in Kumaon and Garhwál (about 8,000) and entered against each the correct transliteration for use in a new edition of the large maps, and then drew up a draft list of names for the district map. I desired to enter the names of all halting-places on every ordinary route; villages in which the patwári usually resides; places of note; trade-centres; and all villages containing over one hundred inhabitants. After much trouble, correspondence, and inquiry, this was fairly accomplished. The villages retained were marked off on the photographic copies of the maps, and these were returned to the Surveyor-General with lists showing the actual and revised spelling for the further compilation. In addition, the principal lines of road have been laid down, and for the first time the pattis or subdivisions adopted at the recent settlement by Mr. J. Beckett have been shown. In the trans-Himálayan portion to which the survey had not extended I have added places from the village maps prepared by the patwáris, and in their selection was aided by Mr. Beckett. The map of the Himálaya-Tibetan region is taken from one prepared by Mr. Trelawny Saunders, omitting the eastern portion. The geological map is a revised copy of that which accompanied General Strachey's paper 'On part of the Himálaya Mountains and Tibet' read before the Geological Society in 1851. It may be necessary to explain that these volumes are not intended to be solely a popular account of the districts which they describe, but to contain, first of all, a record of all facts of permanent scientific or economic value that have been gathered by me during my visits to Kumaon and the Dehra Dún or which have been contributed by others. This work has occupied my leisure time for several years, and I can only hope that the labour and care bestowed on it will be of some use to my successors, and enable them to produce a more worthy record for those who are truly interested in the moral and material progress of the North-Western Provinces.

BOMBAY,
17th December, 1881.

E. T. ATKINSON.

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THE
HIMÁLAYAN DISTRICTS
OF THE
NORTH-WESTERN PROVINCES.

PART I.

CHAPTER I.

INTRODUCTORY.

Limitation of this work—Systematic geography—Herbert; Vigne, Jacquemont, &c.; Hodgson; R. Strachey; Thompson; Cunningham; H. Strachey; Rawlinson; Saunders; Markham; *Calcutta Review;* Blanford—Nomenclature—Ethnical sketch: Plains of Asám and Bengal; Plains of Upper India; Clothing; Food; Customs; Eastern Himalaya—Eastern tribes; Tribes of the Southern Watershed; Bhután; Sikkim; Nepál; Tribes of the Lower *Himálaya*—Karnáli to Tons; Bisahr; the Satlaj to the Indus—Afghánistán, Galcha States; Kára-Tangutans; Tibet—General distribution—Appendix: list of authorities for this Chapter.

Limitation of work.[1]

UNDER the name Himálayan districts of the North-Western Provinces of India we include the British districts of Kumaon, Garhwál, Tarái, Dehra Dún and Jaunsár-Báwar, and the independent State of Tihri or foreign Garhwál, comprising the tract within the Himálaya bounded by the

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[1] The collection of materials for the 'Memoir on the Kumaon Himálaya' has been in progress since 1872, but other and more pressing duties have hitherto prevented their arrangement for publication. It was then intended to give as complete a description of the entire *Himálaya* as the means at our disposal would permit. There is little hope, however, that the leisure necessary for such an undertaking will occur within any reasonable time, and it therefore seems better to work up the materials already existing in their present form than to wait until opportunity is found for completing the original design. There are many and great gaps in our information regarding Kumaon, but the first step towards remedying this defect will be this attempt to take stock of our present knowledge, which is far more complete than is supposed. Without the aid of the materials entrusted to me by General R. Strachey, Sir John Strachey, Mr. J. H. Batten, Rudradatta Pant, and others, whose assistance will be found acknowledged in the preface, as well as the co-operation of Mr. H. B. Medlicott, Mr. S. A. Hill, Mr. Duthie, Dr. King, Dr. Watson, Captain G. Marshall, and others, my own work would be very meagre and unsatisfactory, as well from the great range of subjects discussed as from their frequent special and technical character.

Tons on the west, and the Káli or Sárda on the east. The adjoining portion of Tibet, to which British subjects resort for the purposes of trade, or in order to visit the sacred lakes, also comes within the scope of our investigations. A glance at the accompanying map will show that both the Himálayan and Tibetan portions of the tract with which we are concerned form but a small slice or segment of a greater system, which must be studied as a whole before an adequate conception of the structure and relation of its parts can be arrived at. The Himálaya itself is but the southern belt of that great girdle of mountains which encloses within them the country of which the southern half is commonly called Eastern Turkistán. From or through the southern slope of the Himálaya flow the great rivers known as the Indus, Ganges, and Brahmaputra. To the east, the continuation of the Himálaya is traced in the mountain ranges through which flow the Yang-tse-kiang and the Hoang-ho, and which are prolonged to the north in the Ala-shán, Inshán, and Khing-han mountains. The last of these ranges joins the Yablonnoi Khrebet branch of the Altai system at right angles in about 55° north latitude. The Yablonnoi mountains are the north-eastern continuation of the Altai range and form the water-parting between the Lena and the Amour. The Altai rises, on the right bank of the Irtish river, at the north-western angle of the central plateau, and separates the Upper Gobi from the Siberian steppes. It consists of a belt of mountains varying in breadth from 400 to 1,000 miles, though in one place contracting to 150 miles, of no great elevation, and descending in a succession of broad terraces to the Siberian plains. It is pierced by the rivers draining into Lake Baikal, and, east of the 88th meridian, consists of three almost parallel ranges—the Saiansk, Tangnou, and Ulangomula. From the sources of the Kára-Irtish the Barluk Orochuk and Zungarian Ala-tau connect with the Tian-shán, the Celestial mountains of the maps, in which are the sources of the Syr-Darya or Jaxartes. The Tian-shán to the north and north-east of Káshgar consists of a series of parallel ranges having a direction from the east to west and an increased elevation as they proceed northwards. They abut on the elevated mountainous region known as the Alai and Pámír plateau, the latter of which contains the source of the Oxus in the little *kul* or lake of the lesser Pámír. The eastern margin of the Pámír is described by M. Severtsof, who visited it in 1878, as neither a mountain chain nor the precipitous extremity of a table-land, but an extensive mountainous region filled with numerous ranges. The peak measured by Hayward (21,000 feet), and the Tágharma or Muztágh-Ata peak measured by Trotter (25,350 feet), and supposed to form a part of the Kizil-Art range connecting the Tian-shán with the Himálayan system, are now reported to be only the culminating points of groups of snowy peaks separated from each other by a distance of over thirty miles. The intervening country contains the basin of the little Kára-kul lake surrounded by a complicated system of short and comparatively low mountain ranges having an altitude of from 14,000 to 15,000 feet. These ranges, however, connect with the Hindu Kush, Kárakoram, and Western Himálaya, and thus complete the girdle of mountains from one or another side of which flow all the great rivers of Asia.

Eastern Turkistán.

The country thus defined forms a part of the great Empire of China. To the south lies the rugged, elevated plateau of Tibet, regarding which we shall have more to say hereafter. To the north of this comes the depression known as the Lob-nor basin, which receives the drainage of the northern slope of the Tibetan plateau called, in the 39th degree of north latitude, the Altyn-Tágh range, but more generally known as the Kuen-lun, a name given probably from some well-known pass. The drainage from the eastern slope of the Tian-shán flows in the same direction, as well as that from the south-eastern slopes of the Altai range ; but all is swallowed up in the great sandy desert of Gobi, which at one time apparently formed the bed of an ancient sea some 300,000 square miles in extent. According to Prejevalsky this plateau varies in height from 6,000 feet on the margin to about 2,000 feet in the middle. It is intersected from west to east by a depressed valley called Shamo, or 'sea of sand,' containing salt. West of this lies the Han-hai, or 'dry sea.' Prejevalsky has crossed the desert between Kuldja and what may turn out to be Lob-nor, lying in east latitude 90° and north latitude 39° 30,' and found himself at only 2,500 feet above the level of the sea on the banks of the Tarim. To the west, the desert presented a thin loam impregnated with salt, and to the east a plain of drift-sand. Towards the Kurugh-tágh hills, from which he descended on the desert, lay a belt of pebble and gravel some 15 to 18 miles wide. He also crossed the desert to the north between the Ala-shán range and Urga, where he found it to vary in height between 3,000 and 5,500 feet, whilst it still preserved its sandy character. On the route between Urga and Kalgan explored by the same traveller, there is a great depression towards the middle, where the elevation is as low as 2,400 feet. Here the soil of the Gobi proper is composed of coarse reddish gravel and small pebbles interspersed with drifts of yellow shining sand. Leaving these regions, we shall in future restrict ourselves to the southern plateau, of which the Kuen-lun mountains are the northern boundary, and which is so intimately connected in its physical relations with the Himálaya.

Early attempts at generalisation.

Before proceeding with our examination of the structure of the Himálaya-Tibetan region, it will be convenient to pass in review the different theories[1] that have been advanced in regard to its systematic geography, since a complete understanding as to what has been done in this direction will enable us to arrive at some conclusion as to what remains to be done. Captain Herbert, who conducted the mineralogical survey of the Himálayan country between the Káli and the Satlaj in 1818, was the first who attempted to give a general account of its physical characteristics. His description[2] was intended to serve as an introduction to his geological account of the Himálaya, as well as to be a distinct contribution to general geography; the existing works on the subject "being singularly deficient in details, as well as erroneous in the few that are given." His idea of the country north of India was apparently derived only from maps. He describes it as a large central space strongly marked by the feature that it was little intersected by rivers, whilst from its sides flowed the streams which united to form the greatest rivers in the world. As the source of every river must be higher than any other part of its course, he inferred that the zone in which those rivers originated must be higher than the plains through which they flowed to seek the ocean, and that the entire central tract itself was completely surrounded by lofty mountains. He considered the upper beds of the Brahmaputra

Herbert.

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[1] For a brief summary of these theories see Mr. C. R. Markham's 'Memoir on the Indian Surveys,' p. 341.

[2] *J. As. Soc. Ben.*, XI., Pt. I., p. x.

and the Satlaj as forming part of the barrier zone which surrounds the central tract, and not as a part of the plateau itself. He further showed that the true "line of boundary is undoubtedly the chain of water-heads, and that this is by no means synonymous with the line of greatest elevation." At first view the arrangement of the mountain masses in the tract between the Káli and the Satlaj appeared to be irregular and confused, but by tracing the courses of the rivers and their tributary streams, a clue was found to lead the observer out of this labyrinth. "By connecting their sources and by following out the devious windings of the several feeders, an idea is obtained of the extent, the direction, and the connection of the several ranges. * * * Instead of a succession of parallel and continuous ranges running south-east to north-west, and rising one behind the other in regular array and increasing elevation till the series is closed in the farthest distance by the line of snow-clad peaks, we see only one continuous range of any extent forming an irregularly curved line which bends round the tract, commencing on the north-east angle, and with a north-westerly direction, which it gradually alters to a south-easterly one on the south-west angle, and latterly due south just before it is lost in the plain country. This range forms one of the boundaries of the basin of the Satlaj which bends around the convex side, while within its concavity are contained the numerous sources of the Ganges." This he called the Indo-Gangetic chain, "a ramification of that more extensive line of water-heads which would exclude from the central plateau all the mountain tract watered by the Sanpu and the Indus as well as by the Ganges. Next in extent are the two principal ramifications separating the basin of the Jumna from that of the Ganges, and the basin of the latter from that of the Káli. From these two principal ramifications proceed a number of minor ones which, but for the assistance derived from a study of the course of the rivers, would almost bid defiance to any analysis. Transverse ridges, several thousand feet higher in elevation, ramify from the Indo-Gangetic chain towards the Ganges basin, and a line or plane connecting their summits would be that of the greatest elevation, which, however, has no connection with the disposition of the water-heads. It is a fact that in a line of 500 miles two summits are found exceeding five miles in perpendicular height, not isolated, but connected to appearance by a regular series of peaks of very little inferior elevation. If we confined ourselves to heights of 21,000 feet, we should find a connected line of peaks extending over 1,000 miles; that is, one apparently without breaks, but in reality connected only through the line of water-heads from which they ramify. Whether the word 'line' or 'plane' is used, the idea of considerable breadth must be conceded, and in that case its surface would be very irregularly studded with peaks, and in this way it may be said to be parallel to the common boundary of mountain and plain land, and to intersect instead of bounding the river districts." The above summary gives a *resumé* of Herbert's speculations on the physical structure of the Himálaya. His errors were those of his time, when the knowledge even of descriptive geography was in its infancy. He was unable to recognise the unity of the great central mass and its bulwarks, and was wrong in saying that the groups of snowy peaks intersected the river basins, when, in fact, they bound the drainage area, and are the determining causes of its existence. Still Herbert is to be remembered as the first who attempted to give a systematic account of the Himálaya as a whole,[1] and is therefore worthy of a prominent place in this brief notice of its geography.

Hodgson.

Next to Herbert comes Hodgson, who in an admirable article in the Asiatic Society's Journal[2] also alludes to the difficulty experienced by a traveller in the Himálaya in getting "rid of that tyranny of the senses which so strongly impresses almost all beholders of this stupendous scenery with the conviction that it is a mighty maze without a plan." His first step towards freedom was his grasping the fact "that the vast volume of the Himálayan waters flows more or less at right angles to the general direction of the Himálaya, but so that the numberless streams of the mountains are directed into a few grand rivers of the plains either at or near the confines of the two regions." Secondly, a study of the river systems like the "Sapt Gandaki" and the "Sapt Kausiki" urged him "to discover, if possible, what cause operated this marked convergence of innumerable transverse parallel streams, so as to bring them into a series of distinct main rivers." Thirdly, he found that "the transcendant elevation and forward position, at right angles to the line of gháts of the great snowy peaks, presented that casual agency: the remotest radiating points of the feeders of each great river being coincident with the successive loftiest masses belonging to the entire extent of the Himálaya." The great peaks bound and do not intersect the principal Alpine river basins, as Herbert had thought, and, by so bounding, create the basins, whereas their intersection would destroy them. Hodgson's Himálaya proper is the ghát line or watershed between Tibet and India, and the watershed between the valleys of the Indus and Sanpu and the great plateau is called by him the Nyenchhen Thangla chain. The cause of the convergence of the various streams which form the great rivers upon or near the verge of the plains is shown by him to be "the superior elevation of the lateral barriers of these river basins, between which there are synclinal slopes of such decided preponderance that they overrule the effect of all other inequalities of surface, how vast soever the latter may sometimes be." These lateral barriers are crowned by the great peaks which stand forth from the watershed and send forth southward ridges proportionally immense. Equally effective with the divergent power of these peaked ridges is the convergent power of two ridges upon the single contained river basin. "The synclinal lines from the inner faces of the two adjacent ridges draw the waters together, and because these ridged peaks are the loftiest masses of the entire mountains, the effect of all other masses, even that of the spine of Himáchal or the ghát line of the snows, is overruled or modified, so that in the most rugged region on earth a very limited series of distinct main rivers appear in the plains from innumerable independent Alpine feeders." We may assume that where the loftiest peaks occur, there is a proportionate intumescence of the general mass, and therefore that these grand peak-crowned ridges determine the essential character of the aqueous distribution along the entire line. A further proof is adduced from the fact that the lower rivers, which take their rise in the middle region, do not show this unitizing principle, such as the Bágmati and Rámganga. With regard to the mountain systems, Hodgson divides them into the lower, central, and upper; sub-dividing the first into the sandstone range with its contained Dúns or Máris, the Bhábar or *sál* forest, and the Tarái. The lower region extends from the level of the plains to 4,000 feet above the level of the sea; the central region from 4,000 to 10,000 feet; and the upper region to the watershed or ghát line: divisions which fairly correspond with the distribution of both organic life and inorganic matter. Though unable to follow Mr. Hodgson in all his theories and the deductions that he draws from them, credit must be given for his recognition of the position of the great mountain masses in regard to the alpine river basins and for his appreciation of the influence of climatic conditions on the animal and vegetable world.

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[1] Neither Moorcroft, Vigne, Jacquemont, Hooker, Shaw, Henderson, nor Bellew attempt any description of the Himálaya as a whole.

[2] *J. As. Soc. Ben.*, XVIII., Pt. II., p. 761.

Captain R. Strachey.

Captain (now General) R. Strachey, in his paper on the Physical Geography of the Provinces of Kumaon and Garhwál, read before the Royal Geographical Society[1] in 1851, pointed out distinctly for the first time that the Himálaya was in truth the broad mountainous slope of the great Tibetan table-land descending to the plains of Northern India, while a slope of corresponding character descending to the north is known as the Kuen-lun. He remarks that the great peaks in Kumaon and Garhwál "are not found on a continuous ridge, but are grouped together in masses that are separated one from the other by deep depressions, through which flow the streams that drain those parts of the mountains that are immediately contiguous to the north." To the east the same sort of arrangement obtains, but to the west it is much less distinct. The river-beds to within a distance of ten miles in a direct line from the snowy peaks seldom exhibit a rise of more than four or five thousand feet; but when we cross "the line on which the great peaks are situated, the ascent very rapidly increases, and a very few miles carries the river-bed up to an altitude of nine or ten thousand feet; thus showing that the sudden increase of height of the mountains along this line is not confined to the peaks alone, but is a general elevation of the whole surface." Dr. Thomson[2] substitutes the name cis-Satlaj Himálaya for Herbert's Indo-Gangetic chain, and gives the name trans-Satlaj Himálaya to the chain which, commencing in Kailás, separates the waters of the Satlaj from those of the Indus. He refers to these two great chains the whole of the mountains between the Indus and the plains, and says: "The northern boundary

Dr. T. Thomson.

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[1] J. R. G. S., XXI., p. 57: adopted in Somerville's Physical Geography, 7th edition, London. 1877. p. 56.

[2] Travels, p. 456.

of Tibet is formed by the great chain north of the Indus, to which Humboldt gave the name Kouen-lun": and again, that every part of Tibet is traversed by mountains having their origin either in the trans-Satlaj Himálaya or the Kouen-lun. So far the unity of the Himálaya-Tibetan region is acknowledged by this distinguished traveller. Major A. Cunningham[1] makes the Bara-lacha range, which forms the watershed between the Indus and its five affluents, the continuation of the main Himálaya or watershed between the Sanpu and the Ganges. To the south of this lies two distinct and independent ranges stretching in the same general direction from south-east to north-west, which he calls the mid-Himálaya, or Pir Panjál, and the outer or sub-Himálaya, leaving the name Siwálik unchanged for the lowermost sandstone ranges. Beyond the Himálaya the same system of parallel chains is observed, comprising at least three distinct ranges of mountains, which Cunningham proposes to call the trans-Himálayan, or that which divides the head waters of the Satlaj from those of the Indus and extends to the western limits of Rongdo and Astor; second, the Kailás or Gangri range which runs through the midst of Western Tibet along the right bank of the Indus to its confluence with the Shayok; and third, the trans-Tibetan range, also called Bolor and Kárakoram. These distinctions are however, purely local and geographical and are so far convenient and to be accepted. Captain H. Strachey, in his paper[2] on the Physical Geography of Western Tibet, shows us that the Indian watershed is not the Great Himálaya as seen by the Indian observer, but is found in a succession of valley heads much depressed and penetrating that mass to such a depth that the passes from India to Tibet are never visible from any station fairly south of the perpetual snow. The Turkish watershed divides the waters of Tibet from those of Turkistán, including Khoten and Káshgar. "The general plan of the mountain system of Western Tibet appears to consist of a series of parallel ranges running right across the breadth of the tableland in a direction so extremely oblique to the general extension of the whole as often to confound the one with the other, or to convert the transverse direction to a longitudinal one. Short transverse necks connecting the main ranges in some parts, and cross fissures cutting

Major A. Cunningham.

Captain H. Strachey.

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[1] Ladák. p. 41.
[2] London. 1854.

through them in others, together with projecting spurs of a secondary order, will suffice to convert the supposed primary arrangement into all the existing variety of valley and drainage.**The great snowy peaks lying mostly on the terminal butt-ends of the primary ranges, sometimes widened by lateral spurs; and the Tibetan passes crossing the low connecting links, whose alignment forms the main watershed, but not the main mountain-crest." Sir H. Rawlinson[1] recognises the unity of the entire mass, and writes that the "whole country between India and Tartary may be considered as a broad mountain range, the Himálaya forming the southern crest, and the Kuen-lun the northern. The direction of this range is from east to west, trending to the northward, while the parallel chain which bounds Siberia to the south, and the outer crest of which is the Tian-shán, trends somewhat to the south; so that at a short distance to the west of Yárkand and Káshgar the great interior depression of Chinese Tartary terminates, and the bounding ranges coalesce in the elevated table-land of Pámír."

Sir H. Rawlinson.

Mr. Saunders' theory.

We have now come to the theory set forth by Mr. Trelawny Saunders,[2] Geographer to the India Office, according to whom the summit of the Himálaya consists of a double range of peaks enclosing a series of valleys running parallel to the axis of the mass, and which he would call the northern and southern Himálaya respectively. The first of the two forms the water-parting between the Ganges basin and that of the Sanpu. To the latter must be assigned nearly all the great snowy peaks which are seen from the plains of India, and which are separated from the former by the valleys already mentioned. These valleys are comparatively elevated, and at length burst through the southern range by intersecting gorges. Both Herbert and Hodgson are set aside, and the great peaks are described as forming a chain, broken at intervals by intersecting gorges. "The upper valleys of the Sanpu, the Satlaj, and the Indus appear to form a huge elevated trough separating the Himálaya from the northern part of the table-land of Tibet and from the snowy range into which the table-land contracts at its western end." This range is crossed by the Muztágh, Kárakoram, and

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[1] England and Russia in the East: London, 1875, p. 236.

[2] Sketch of the Mountains and River Basins of India: London, 1870.

and Changchenmo passes, and is remarkable for the great length of its glaciers and the great height of its peaks. The Indus forms its southern base as well as the northern base of the Himálaya. The Indus, Satlaj, and Sanpu, "are the only rivers which, washing the northern base of the Himálaya in channels parallel to the range, break through the entire breadth of the range and water the plains at its southern base." The eastern base of the mountainous highland of Tibet is marked by the Min river, and on the north-east the slope is defined by the basin of the Hoang-ho. From the latter river westward to the Muztágh the Kuen-lun mountains descend to the plains of Gobi from the northern edge. These unite with the Himálaya, Pámír, and Hindu Kush in the lofty peak or knot called Pusht-khar or Tághdambash. The accompanying map, prepared by Mr. Saunders for Mr. C. R. Markham's Memoir on the Indian Surveys, will illustrate better than any further quotations his views on the subject of the relations of the great mountain systems, as well as serve our own purpose. Mr. Markham[1] divides the Himálayan system into three great culminating chains, which he calls the inner, central, and outer, running more or less parallel to each other from the gorge of the Indus to that of the Dihong. "The lofty region of Great Tibet lies mainly between the inner and outer range, with the central chain, whence most of the rivers of Northern India take their rise, running through its length." The western extremity of his inner and most northern range is the Kárakoram, which separates the Indus valley from the affluents of the Lob-nor system, and the eastern section is the Gangri mountains of the map, the Nyenchhen Thangla of Hodgson and Ninjinthangla or Nyenchhen-tang-la of Markham, which commences in peak or knot called Kailás. Parallel to the northern range runs the central range, the eastern section of which commences at the Mariam-la pass near the Kailás peak. "Here a comparatively low saddle connects the northern and central ranges and separates the valley of the Satlaj from that of the Brahmaputra. To the eastward the northern side of the central chain forms the southern watershed of the Brahmaputra, whilst on its southern slopes are the sources of many important rivers, which, forcing their way through the southern chain of the Himálaya, eventually join the Ganges or

Mr. Markham.

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[1] Tibet, p. xxiii., 1876.

the Brahmaputra." The southern chain is made up of the series of snowy peaks which, to the east, overhang Nepál, Sikkim, and Bhután. Thus, Mr. Markham is at one with Mr. Saunders in his theory as to the Himálayan system, only substituting the terms "inner or northern, central and outer or southern," for the terms "Gangri, northern and southern Himálaya," used by Mr. Saunders.

Calcutta Review.

A writer in the *Calcutta Review*[1] has taken objection to the creation of the southern chain, which, "being occasionally intersected by rivers of more remote origin, is not a chain at all, but a series of spurs running southwards from an extended line of elevation more to the north, in the neighbourhood of which the said rivers rise." He also suggests for the whole system the name Indo-Tibetan, correctly urging that it is undesirable to give to the whole a name which belongs only to a part. He prefers simply to lay down two lines of watersheds, the northern corresponding for the most part with Mr. Markham's inner range, and the southern extending from Chilás by the Zoji-la, Baralacha, Níti, and No passes to the Laghalangla above Shikatse. He then examines the river basins and shows that Hodgson's theory regarding them is in accordance with facts; that these basins derive much of their water from certain prominent peaks which, standing in advance—that is, southwards of the watershed—are connected with it, and from which ridges with dependent spurs project, that serve as lateral barriers to the basins. "The preponderating synclinal slopes of the ridges and spurs which overrule the effect of all other intervening inequalities of surface, however vast, cause the several groups of mountain streams between them to converge till they unite and constitute a main river near the edge of the plains." This is practically Hodgson's law re-affirmed in the full light of all that modern research has shown us regarding the geography of Tibet, the Kárakoram and Káshgar, a *terra incognita* to our early writers.

Rejoinders of Mr. Markham and Mr. Saunders.

Both Mr. Markham and Mr. Saunders have issued rejoinders to the criticisms in the *Calcutta Review* in two articles in the *Geographical Magazine.*[2]

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[1] January, 1877, p. 145.

[2] By Mr. C. R. Markham in May, 1877, and Mr. Saunders in July, 1877, Geo. Mag. IV, 113, 173, London. The other matters in controversy between the reviewer and Mr. Markham are omitted as foreign to the subject of this notice.

Mr. Markham chiefly confines himself to a defence of his use of the word 'chain' as applied to a series of culminating ridges, whether rivers force their way through its gorges or not; but Mr. Saunders goes more fully into the entire question at issue between him and the reviewer, and supports his arguments by a re-statement of his views on the physical geography of the entire Himálaya-Tibetan system. For this purpose he draws largely on his "Sketch of the Mountains and River Basins of India," already noticed, in which the theory of the southern chain of snowy peaks was first developed; and whether we agree with his deductions or not, we must consider his summary as a valuable contribution to our knowledge of the subject. He recapitulates the arguments in favour of considering the line of snowy peaks a southern chain, and concludes that they are entitled to that name, "(1) as the culminating summit of the southern or Indian slope; (2) as the common origin of a succession of rivers; (3) as cut off from the northern range by a succession of remarkable valleys, sometimes very long, sometimes very deep, and sometimes very broad and flat, and all containing considerable rivers running parallel to the chains which they divide." He objects to the inclusion of the mountain ranges on both sides of the troughs of the Indus and Sanpu under the term Himálaya, the northern watershed of those rivers composing the contreforts, buttresses and slopes or escarpments of the great central plateau which they uphold and from which they cannot be separated. The table-land is Tibetan; therefore its southern slope cannot be called Himálayan. The remaining portion of Mr. Saunders' article will be noticed as we proceed.

Mr Blanford.

The latest contribution to the physical geography of the Himálaya is to be found in Mr. H. Blanford's Manual[1] and Mr. W. Blanford's introduction[2] to the "Manual of the Geology of India." In the latter work, which may presumably be taken as giving Mr. W. Blanford's conclusions on the subject, he considers the Himálaya to form a curved belt of mountains with their convexity to the southward which mark the southern scarp of the Tibetan plateau as the

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[1] Physical Geography for the use of Indian Schools, Calcutta.

[2] Calcutta, 1879, I., ix. It should be remembered that the term 'range', is used here for geological purposes which are not always the same as those intended by geographers. Its precise meaning depends on the context.

Kuen-lun define the northern. The western terminal portion of the Himálayan chain comprises a number of great ranges variously named. It is doubtful whether any of these "should be considered the prolongation of the main Himálayan axis, although, if any be really a continuation of the Himálaya proper, it is either the Pir Panjal or the Zanskar range." Geological considerations would lead him to suppose that "the main range commences on the westward in the Dhauradhar near Dalhousie, and extends to the east-south-east till it rises into the main snowy range of the north-west Himálaya. Many geographers distinguish two parallel ranges from the neighbourhood of Simla to the eastward; the snowy range proper, formed of the highest peaks (Saunders' theory), and a more northern ridge, forming the watershed between the Tibetan plain and the rivers running to the plains of India. Others consider the latter to be the true Himálayan range, and look on the higher peaks as belonging to the spurs between the rivers flowing from that range. It is certain that the great peaks, such as Nandadevi, &c., are separated from each other by deep valleys, through which flow streams coming from the northern range, and that, although the peaks of the latter are inferior in elevation, the passes by which it is traversed are much higher; but it has not yet been ascertained whether the great peaks are on the strike of any continuous band of rock, or whether they merely consist of hard nuclei left undenuded." There is little doubt that, until the geologist is able to assist us, the question whether the line of snowy peaks should be considered a true chain or merely spurs from the main water-parting must be left undecided. Though year by year fresh materials are added to our stock of knowledge regarding the Himálaya, they are yet too imperfect for us to offer little more than a suggestion as to the views that should be adopted regarding its structure. A glance at Mr. Saunders' map will show us the vastness of the subject, and that the Himálaya of Kumaon and Garhwál, with which we are more immediately concerned, is but a very small portion of the great girdle of snowy peaks that uphold between them the elevated plateau of Tibet. Herbert showed us that this girdle, as seen from the plains of India, is not a continuous line of parallel ranges rising one behind the other, and increasing in elevation until the series is closed in the farthest distance by the line of snow-clad peaks; but that these peaks or groups of peaks are ramifications from the line of water-parting which itself is lower than the line of greatest elevation. Hodgson subsequently explained the influence of these groups of peaks on the river-systems, and Captain Strachey showed us that the Himálaya was the southern slope of the Tibetan plateau as the Kuen-lun formed its northern slope. These are, broadly, the more important additions to our knowledge of the physical geography of the Himálaya that have been made of late years. To our mind the recognition of the unity of the entire Himálaya-Tibetan system is the most important of them all, and that alone which will lead to practical results. The division of the Himálaya into ranges may be allowed as a matter of convenience, but should not be permitted to cloud the great fact that all are but variations in the southern slope of the great table-land due to the influence of the elements on the materials of which they are composed, and to the disturbing action of subterranean forces. We can lay down the line of water-parting and the line of greatest elevation with some precision, but must call in the aid of the geologist and mineralogist to distinguish which amongst the ranges is entitled to be called the real main axis of the Himálaya; and, until their labours are communicated to the world, must rest content with the somewhat arbitrary distinctions afforded by the prominence or otherwise of existing physical features.

Nomenclature.

Seeing the misunderstandings that have arisen from a too loose use of words and phrases, it will be as well to state here that we adopt the word 'water-parting' to represent the ridge which separates the flow of water on either side of a range of hills.[1] The word 'range' will include a series of mountains or hills continuing in one direction along a common axis, whether broken by chasms or not; and the word 'spur' will be used of a ramification from a range, whether connecting it with another range or sinking gradually into a plain.

The great mountain chain lying between Tibet and the plains of India is generally known to the natives of India by the term *pahár* (mountain), to which they prefix the local name where such exists.

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[1] The use of this word in this sense is one of the subjects of controversy between the Calcutta reviewer and Mr. Markham. The former (p. 147, note) objects that the old word 'water-shed' is sufficient.

The more educated give the name Himáchal[1] (snowy-range) or Himálaya (abode of snow) to the snow-covered ranges; whilst Europeans popularly include under the name Himálaya the entire mountainous region lying between the gorge of the Brahmaputra on the east and that of the Indus on the west, and between the upper valleys of the same rivers on the north and the plains of India on the south. A first glance at any good map will convince us of the general unity of the physical relations of the range within the limits commonly assigned to the Himálaya, whilst a closer examination will induce us to include much more. For our part we accept the popular definition of the Himálaya as extending from the gorge of the Indus on the west to that of the Brahmaputra on the east, and from the upper courses of the main branches of those rivers on the north to the plains of India on the south, speaking of its connections beyond those limits as the western and eastern extensions respectively.

Ethnical sketch.

It will materially aid the reader if we further preface our remarks with a short description of the ethnical and political divisions of its surface, and of the regions in immediate contact with it. We have arrived at some idea of the physical relations of the tract itself, and shall now, at the risk of being thought diffuse, endeavour to trace the ethnical affinities of its inhabitants. Commencing, then, with the plain on the south, we find the provinces of British India flanking the foot of the Himálaya along its entire length from the 96th to the 72nd meridian of east longitude. Following the direction of the Himálaya from east to west, we find in Upper Asám a number of tribes speaking different languages and dialects, and so intermixed and blending the one into

[1] The word Himáchal (हिमाचल) is derived from two Sanskrit words, '*hima*' (snow) and '*achala*' (mountain), meaning 'snowy-mountain' or 'snowy-range. Similarly the word Himálaya (हिमालय) is derived from '*hima*' and '*alaya*' (abode), meaning the 'home' or 'abode of snow.' The proper pronunciation is therefore Him-á-lay-a, *not* Him-a-láy-a as commonly obtains. The plains-men speak of the Simla-*pahár*, the Mansuri-*pahár*, and sometimes of the snowy-range as the *barf* (ice)-*pahár*. "The people south of the Himálaya in Nepál call all snowy mountains *langar*, by which they mean the highest points. They call the peaks that have no snow *banjang*, and the low ground under the said *banjang* they call *phedi*. The term Himálaya is not used by uneducated people, who only talk of the snowy mountains as '*barfáni langar*.'—*G. T. S. Rep.*, 1872, p. 46.

the other that, beyond a mere cursory description, their classification cannot be attempted here. In the extreme north-east they are allied with or are members of the tribes inhabiting the neighbouring hills, of whom more will be said hereafter. They speak a language having an affinity with the great Barma-Tibetan group, and are mere pagan savages. Along either side of the Brahmaputra in its course through the valley we find the settled tribes of Asám speaking a language akin to Bengáli. Though differences exist they so closely resemble in habits and character the people of the conterminous parts of Bengal that it is difficult to draw a strict line of severance between them without entering into long historical and ethnical discussions quite out of place here: many that are now Hindu or Musalmán Bengális in all outward appearance can be shown to be converts in recent times from the pagan tribes in their neighbourhood of unmistakably aboriginal origin. The people of Bengal, the flat alluvial plains of which lie along the lower courses of the Ganges and Brahmaputra, exhibit all the features characteristic of a race inhabiting a region of tropical heat and moisture. They are small in stature, of dark complexion, and effeminate in character, living chiefly on rice grown in the lowlands subject to annual inundation. Their dress is of the scantiest proportions, consisting chiefly of one or two pieces of cotton cloth simply wrapped around their waist and shoulders, and not wrought into any form of garment. Their heads and feet are usually left bare. Their houses, constructed of mats, lie scattered amongst the thick groves of bambus and palms that spring up in wild luxuriance on the uncultivated ground.

Plains of Asám and Bengal.

As we ascend the Ganges,[1] we find a drier climate with greater contrasts between the summer and winter temperature, and a taller, more manly, and more robust race, of whose food the millets and unleavened bread of wheat, barley, and other grains form the principal element. Their clothing is more elaborate and warmer than that of the Bengáli. All wear turbans, and those who can afford it have short jackets fastening on the right breast in the case of Hindús, and on the left breast in the case of Musalmáns. Their houses are built of mud and are either

Plains of Upper India.

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[1] This account of the Hindús in the plains is partly based on Elphinstone and Notes by General R. Strachey.

tiled or thatched in the villages, but in many of the towns very small bricks are used in the construction of the better class of dwellings. The country is open and unenclosed, and almost the only trees are groves planted near towns and villages, with occasional patches of *dhák (Butea frondosa)* and *babul (Acacia arabica)* jungle. The people are mostly Hindu in religion and speak dialects of Hindi. On approaching the Satlaj the language passes into Panjábi, also Sanskritic in its character, and we find the religion of the Sikhs the seal of the double dispensation of Brahma and Muhammad.[1] To the west of the Panjáb, or country of the five rivers, the religion of Islám predominates amongst a motley group of tribes of very varied origin. The name Hindustán, which is more correctly applied to the northern Gangetic districts alone, may without impropriety be used so as to include the entire tract below the Himálaya. Intersected by the innumerable streams that flow from the mountains above it, watered by the copious falls of periodical rains, and enjoying a semi-tropical climate, the great unbroken plain is thus supplied with the two great requisites, heat and moisture, that are the necessary and certain agents for the development of vegetable life. We naturally, therefore, find an agricultural population often in the older settled parts extremely dense, and attaining to no small degree of civilisation. Cities and large towns are common, many with a population of over 50,000 souls; and the inhabitants, without coming up to a European standard, enjoy considerable wealth. Literature, both indigenous and of European origin, is cultivated; schools are numerous, and the useful arts are highly advanced and eagerly followed. The hot climate which induces a love of repose and fertility of soil which renders severe labour unnecessary has, in some measure, modified the habits of patient industry which are usually characteristic of an agricultural population; but the dislike to change which marks those communities in all parts of the civilised world is nowhere more strikingly exhibited than in Hindustán. The great wealth of the country and its open and easily accessible character, together with the insuperable obstacles to union presented by differences in race and caste, have, for many centuries, subjected it to the reiterated attacks of foreigners. With very few exceptions all truly national government has ceased to exist; and from what little we know regarding it, the people have small cause to regret the successive changes of masters. India has never had in the whole course of its history so strong, universal, and just a government as it has enjoyed under the British since the memorable mutiny of 1857. Englishmen may well point with just pride to the lengthy catalogue of measures attesting true moral and material progress that have been introduced during the last quarter of a century, and have been assimilated by the people to such a degree that the advance —political, moral, and social—made has eclipsed all that had been previously effected under British rule.

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[1] Cunningham, History of the Sikhs, p. 18.

Clothing, food, customs.

Taking the people of the plains as a whole, their clothing is cotton and their food is vegetable, though Musalmáns and some Hindús eat meat and a few eat fish. The dress of the men, as a rule, is white, though they often wear coloured jackets; the women, who have no other covering for their heads than a corner of the cloth that they wrap round their bodies, frequently wear bright colours, usually indigo blue, Turkey red, or safflower yellow. The Hindús preserve their moustache, but shave their beards, and frequently their heads, except a small scalp-lock, whilst the Musalmáns allow their beards to grow. The seclusion of women seems to be a custom introduced by the Muhammadans, but amongst all religions and races in Hindustán the position of females is essentially inferior to that of the other sex, with whom they do not mix in society. Marriages are almost always contracted in childhood, and the betrothed bride is always under the age of puberty. Amongst Hindús, a dowry is given with the daughter, though the practice of accepting a sum of money for a daughter is in many parts of the country gaining ground. Female infanticide has been rife in the Gangetic districts of Upper India, due to the disgrace supposed to be attached to the expression 'father-in-law,' as well as to the great expenses ordinarily consequent on the marriage of a daughter. The education of women is absolutely neglected, and the efforts of Government in this direction have proved a total failure. The men, however, for the most part, amongst the classes above those actually engaged in the cultivation of the soil, can read and write, and even the men who have not acquired those attainments possess the power of mental calculation to a remarkable degree. The Brahmanical faith is with few exceptions dominant throughout Hindustán. The Musalmáns are, however, numerous everywhere, and in some districts are in the majority. They belong chiefly to the Suni sect, but Shiahs are also found in certain tracts where the influence of powerful families of their persuasion has been felt. The peculiar modification of Hinduism adopted by the Sikhs is chiefly confined to that portion of the Panjáb which lies east of the Chináb. To the west of that river, the great mass of the population is Muhammadan. Taking the people of the Panjáb proper, excluding Peshawar and the trans-Indus districts attached to the Leia and Multán divisions, we have a population of ten millions, of whom seven-twelfths are Musalmáns, four-twelfths are Hindús, and one-twelfth are Sikhs. Distributing them according to race, General Cunningham[1] makes 3 per cent. of so-called early Turanian origin, 27 per cent. Aryans, and 70 per cent. later Turanians.

Eastern Himálaya.

We shall now consider the ethnical and political divisions of the Himálaya itself, proceeding in the same direction from east to west. At the extreme east we have the same races speaking a Barma-Tibetan language that we found in the plains, but a line drawn north and south across the Brahmaputra, in the general direction of the Dhansiri river, and continued southwards so as to leave Kachár to the west of it, would, according to Hodgson, divide them from the Alpine races of more pronounced Tibetan stock, as well as from the so-called aboriginal tribes of the central Himálaya. These Barma-Tibetan tribes are known as Abors, Bor-Abors, Daphlas, Akas, Mishmis, Miris, &c., and their communities are reported to have a sort of rough republican constitution. This conjecture of Hodgson appears to be supported by the result of the most recent investigations.

Eastern tribes.

The country lying on the Táwáng route by the Dhansiri river from Asám to Chetang in the valley of the Sanpu, in the 92nd meridian of east longitude, has been traversed by one of the Pandits of the Great Trigonometrical Survey, from whom we learn that to the east of that line the Himálaya is inhabited by Lhoba Daphla tribes.[2] These men are remarkable for the abnormal development of the muscles of the arms and calves of the legs. They wear cylindrical-shaped hats made of bambus, and their only garment is a long blanket folded somewhat after the fashion of a plaid and fastened round the waist by a cloth girdle, which is used as a quiver for their arrows, which all carry, as well as a bow slung over their left shoulder. The greater part of their legs and arms is bare. They wear no boots, but ornamental rings made of rope, fastened very tightly both on the wrists and legs below the knee. They have a decided Tibetan caste of feature, high cheek-bones, and Chinese-looking eyes. They wear no hair on the face, but the hair of the head is allowed to grow to a great length, and is drawn together behind the head and then allowed to hang down.[1] They appear to be distributable into two groups—those living in the great rice country to the north on the banks of the Sanpu, called Lho-khâls, and who are independent of the Lhása authorities; and the Shiyár Lhobas, a wild race who inhabit the country through which the great river flows to Gaya, Asám, and who may be identified with the wilder tribes of Mishmis. The Mishmis are distributed into three great divisions comprising numerous clans—the Chúlikáta or crop haired, the Midhu, and the Digáru, each of whom have a separate dialect, and the last reside within British territory along the hills as far west as the Digáru river. The Abors or Pádams inhabit the country to the west of the Dibong river. They are described by their neighbours as exceedingly fierce and blood-thirsty : "like tigers, two cannot dwell in the same den. Their houses are scattered singly or in groups of two and three over the immense extent of mountains inhabited by them." They manufacture the weapon called *dao*, and weave coarse cloth, which with *manjít*, beads, bell-metal cooking vessels, female slaves or rather wives, and the breed of cattle called *mithuns*, are exchanged for salt and coarse cloth imported by the Miris from the plains. The Miris are more civilised than the Abors, and dwell in villages both in the hills and plains. The Akas or Hrussos live between the Miris and the Daphlas on the upper waters of the Sundari, and call themselves Tenae. The women of the Akas wear blue or black petticoats and jackets of white cotton of their own manufacture. Their faces are tattooed, whence the name "Aka" given them by the people of Asám. The males wear a girdle of canework painted red, which hangs down behind in a long bushy tail. Their staple food is rice, but everything edible is made use of. The

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[1] Cunningham's Arch. Rep., II., 2, 4.

[2] See section A. of references attached to this chapter.

[1] G. T. S., 1879, p. 70.

Daphlas belong to the same stock, and all are mere pagan savages, debased, cruel, and treacherous, though in the last respect the Akas have a somewhat favourable report.

Tribes of the southern water-shed.

To complete our review, we shall diverge to the south of the Brahmaputra and briefly notice the tribes inhabiting its southern water-shed.[1] In the extreme east we find the Khamtis or Shans, a tribe linguistically allied to the Siamese and Buddhists in religion; next we have the Singphos, or Kakhyens, and the Jilis, on the northern slopes of the Patkoi range, both of whom are pagans and speak a language intermediate between Barmese and Tibetan. Further west come the Nágas, who are distributed into three great classes—the Namsang, Khari, and Angámi. They are the most numerous of all the pagan tribes to the south of the Brahmaputra, extending from the Kopili river in the meridian of Nowgong on the west to the meridian of Sadiya on the east. They bury their dead and appear to manage their affairs in a sort of republican assembly. The Kopili river separates the Nágas from the Khasiyas of the Jaintiya and Khasiya hills around Shillong. The Khasiyas appear to be an isolated group, speaking a monosyllabic language which cannot be classed with any other of the same family. The form of government is republican and the religion is mere paganism. To the west are the Gáros, who also are pagans, though their language has affinities with the Aryan dialects spoken on the north, south, and west. The language, however, has a Tibetan basis, and Hodgson would include it in the Bodo group, of which more hereafter. South-west of the Nágas come the tribes of the Manipur, Lusbái, Tipura (Tipperah), and Chittagong hills. From McCulloch and Damant we learn that there are numerous dialects in Manipur, and that the principal has a character of its own derived from the Nágari. The inhabitants have adopted the Brahmanical faith. The people further west are known as Kúkis, and appear to speak four dialects of a common stem-language:—the Lushái spoken by the Dzos of the Lushái highland, the Thadu in northern Kachár, the Kúki in the same district, and the Hallámi in the Tipura hills. The Kúkis are pagans, but are gradually yielding to the influence of their Brahmanical neighbours, as indeed are all the pagan tribes similarly situated in the Asám valley. We shall now return again to the tribes inhabiting the Himálaya to the west of the Dhansiri river.

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[1] See section B. of references attached to this chapter.

Táwáng.

The whole country along the Táwáng route from Asám to the head of the valley leading down to Chetang on the Sanpu is under the rule of the Lhásan Jongpen of the Chona Jang. The Lámas of the great lamasery of Táwáng, however, own the country to the south of the range of hills which form the water-parting between the Táwáng and Dhirang valleys, and are entirely independent of Lhása. They manage all public business in an assembly of the principal Lámas, called the *Kato*, which is also the supreme court of justice. To the north, near the Chetang valley, the elevated highlands are occupied by nomad tribes; but to the south, in the Mon-yul or Sub-Himálaya, the country within which Táwáng is situated, the people are called Monpas or Hill Indians, and differ materially in language, dress, and manners from the Bodpas, or people of Bod-yul to the north of Chona. The Monpas resemble the inhabitants of Bhután on the west. They wear their hair closely cut round the head, not in plaited tails as in Tibet, and as a covering have a small skull-cap of woollen cloth or felt. Instead of the long gown of Tibet a short coat is worn which reaches to the knee, and is fastened by a woollen girdle that invariably holds a long, straight knife. The people keep cattle, sheep, and pigs. Thus, the line drawn north and south by the Dhansiri river passes through this wedge of Tibetan territory, separating the Barma-Tibetan tribes on the east from those who have a more pronounced Tibetan origin in the central Himálaya and the so-called aboriginal tribes of the lower Himálaya on the west. Hodgson assigns to the latter the name Tamulian, but it cannot stand, involving as it does linguistic and ethnical associations which modern research has failed to establish.

Bhután, Sikkim.

To the west of the Dhansiri river we have the countries of Bhután, Sikkim, and Nepál, all of which possess a more or less established form of government.[1] Much has been written regarding the people inhabiting those countries which we can but very lightly touch upon here. The entire tract may be divided into three great belts,—the elevated region beyond the snowy range that is visible from the plains, varying from 10,000 to 16,000 feet above the level of the sea; the central region, varying from 4,000 to 10,000 feet; and the lower region, extending from the plains to 4,000 feet.[1] To the central region are confined the Lhopás, Lepchás, Limbus, Kirántis, Murmis, Newars, Sunwárs, Chepángs, Gurungs, Magars, and Khasiyas. To the lower regions belong the Koch, Bodo, Dhimál, Kíchak, Tháru, Denwar, and Pallah tribes. The inhabitants of the central region belong to a comparatively recent Tibetan immigration, whilst those of the lower region, the so-called Tamulian aborigines, are apparently to be ascribed partly to an early Tibetan immigration and partly to an Aryan source. To the north, along the entire line of gháts from the 92nd meridian to the Jumna, we find the Bhotiyas or Bod-pas of pure Tibetan origin and Buddhists in religion. Bhután, the Lho-pato, Lho-duk, or Lho-mon of the Tibetans, is also a Buddhist country, as well as Sikkim, the Demojong of the Tibetans. Nepál, called Palbo by the Tibetans, is partly Buddhist and partly Brahmanical in religion. In the central Himálaya of Bhután and Sikkim we find the Lhopás, Lepchás, and Limbus. The name 'Lhopa' seems to be a generic term signifying the people of Lho or Bhután, as 'Bod-pa' means a person of Bod or central Tibet, and 'Kham-pa,' a person of Kham or eastern Tibet. So also the term 'Dok-pa' is the religious equivalent of the territorial term 'Lho-pa.' The Lepchás extend from Panákha in mid-Bhután on the east into eastern Nepál on the west. They are divided into the Rong and Khamba tribes. The women of both divisions wear a loose coat of the fibre of the silk-worm that feeds on the castor plant, or of unbleached cotton with a wrapper of the same material around the waist to form a petticoat. The men wear a robe of striped red and white cotton cloth crossed over the breast and shoulders and descending to the calf of the leg, leaving the arms bare; a loose jacket of red cotton cloth is worn over the robe by those who can afford it, and both are bound round the waist by a red girdle. Some strings of coloured beads round the neck, silver and coral earrings, a bambu bow with a quiver of iron-pointed arrows, and a long knife complete their costume. This knife, called '*bán*' by the Lepchás and '*chipsa*' by the Bhotiyas, is worn on the right side, suspended from the left shoulder, and serves as an axe, hoe, spade, sword, and knife. The Lepchás eat any flesh of bird or beast, all cultivated and many wild grains, and drink beer and tea. They are Buddhists in religion. Their language, though allied to Tibetan, is not Tibetan, and has a character of its own. They bury their dead; though the Murmis, a tribe of the same country, first burn their dead and then bury the ashes. The Lepchás are short in stature, averaging about five feet, bulky for their height, and rather fleshy than sinewy. They have a fair complexion, pleasantly marked Tibetan features, and part their hair along the crown of the head. Both sexes allow it to grow long; the younger males allow it to hang loose over the shoulders, whilst the elder males and women plait it into tails, and the latter tie the ends with braid and silken cords and tassels. Like all Buddhist hill-tribes they are very filthy in their habits, ablution being unknown.

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[1] See section C. of references attached to this chapter.

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[1] Better known as Hodgson's belts.

Limbus.

The Limbus are an important tribe of the central Himálaya, found between the Tista on the east and the Dúdh-Kosi on the west. The word 'Limbu,' according to Dr. Campbell, is a corruption of the term 'Ekthumba,' the correct name of this people, and used generally to designate the whole population of this portion of the Himálaya not included amongst the well-known divisions, such as Lepchás, Murmis, Bhotiyas, and Parbatiyas. Under the name Limbu are included the Kirántis or Kirátis, Ekas, and Ráis, and their country is divided into Kiráti-des from Dúdh-Kosi to the Arun and Limbua from the Arun to the Konki river, which leaves the Nepál hills about twenty miles to the west of the Mechi river. Further east and west they occur only in small colonies. Hodgson records the vocabulary of seventeen dialects of the Kiráti language, none of which are referable to the written Tibetan or Hindi. They are pagans in religion, though willing to pass themselves off as followers of Hinduism or Buddhists where those religions prevail. Their features, the absence of a beard, and the colour of their skin, all show them to be of Tibetan origin. The Limbu wears his hair long, but does not plait it; he carries a *kukhri* or curved knife instead of the *ban*, and has a wide trousers and jacket instead of the robe and long jacket of the Lepcha. Both tribes are found at elevations of from 2,000 to 4,000 feet above the level of the sea.

The Hayus or Vahus prefer the lowest elevations in the valleys, and occupy the central and lower ranges of the mountains of eastern Nepál between the Arun river and the Konki. They are found mixed with the Eka division of the Limbus, but possess clearances and villages of their own. They differ from all around in language, religion, and habits, and are esteemed an outcast race by the Gurkhális. They do not intermarry or hold intercourse with other tribes. The Bramhus, similarly placed in the Noakot valley to the west, speak a Barma-Tibetan dialect and are also pagans. The great bulk of the Murmis are found between the Nepál valley and the Dúdh-Kosi, whence in smaller numbers they extend to the Tísta on the east and as far as twenty miles west of Kathmandu on the west. They are divided into two classes: one from the Ni district in Tibet, and the other from the Tsang district; hence the generic name Nitsang or Nishang applied to the whole tribe. They prefer elevations of from 4,000 to 6,000 feet and engage in pastoral and agricultural operations, living in cottages built of stone and thatched with grass. They are Buddhists in religion and their language is akin to Tibetan. In their physical traits they resemble the Lepchás, though somewhat taller. The Newars compose the majority of the inhabitants of the Nepál valley, but are not numerous beyond its limits. They are a shorter race than the Gurkhális, and their appearance betrays their transmontane origin. The greater number are Buddhists, and the remainder profess the Brahmanical faith. They possess a written character of their own and speak a distinct dialect, though the Buddhist portion also use Tibetan, in which their religious books are chiefly written. In the forests to the west of Nepál, close to the plains, we have the wild tribes known as Chepángs and Kusundas, the former clearly akin to the Rájis of Kumaon. They speak a language allied to that of the Lhopás of Bhután. In the same direction are the Hinduised tribes of Khasiya, Magars and Gurungs, generically known as Parbatiyas. They speak a language having a Tibetan basis, and into which many Hindi and Urdu vocables have been introduced. The Gurungs, like the Murmis, prefer elevations of 6,000 feet, and are partly pagan and partly Hindu in religion. The Magars are entirely Hindu in religion, and to them

Nepál.

belong the Thápa clan so famous in later Nepálese history. Both these tribes supply numerous recruits to the regiments in the British service, and to this is probably due the Indianised form of their speech. North of them we find the Sunwárs, and on the west the Thaksyas (Thakuris ?), and on the east the Pahris. Vocabularies of the languages of these tribes have been preserved by Hodgson.

The Gurkhális speak the Hindi dialect called Nepálese Khas or Parbatiya. In summer they wear a sort of pantaloons called *páejámas* and a jacket or coat of white or blue cotton, and in the winter the same padded with cotton or lined with fur and fastened by a cotton girdle, which invariably holds the heavy, crooked knife, called *kukhri*. Turbans of dark cloth or loosely-folded cotton are used as a head-dress, or small tinsel, embroidered skull-caps. The Newárs wear a waist-cloth of cotton and a jacket of the same, or some woollen materials. Some adopt the Tibetan costume of full short trousers, a long tunic, and a fur-edged cap. The head-dress is a small skull-cap of black or white cloth thinly wadded with cotton and generally turned up an inch or so at the border. The dress of the other inhabitants of Nepál differ little from that already described. The women of the Newárs wear their hair gathered into a short thick club at the crown of the head, whilst others have it plaited into a long tail. Flesh is much more commonly used by all classes than in the plains. The lower classes drink a coarse fermented stimulant called *rakshi*, and the higher classes, when they can afford it, consume large quantities of tea.

Tribes of the lower Himálaya.

Taking now the tribes inhabiting the lower Himálaya to the north of the Brahmaputra, we find on the extreme east the Deoriya Chutiya, the remnants of a powerful tribe, who though Hinduised in religion preserve their old language, which is affined to the Barma-Tibetan group. Next come the Dhimál, Kachári or Bodo, and the Koch. Hodgson tells us that in travelling between Gwálpára in Asám and Aliganj in the Morang Tarái of Nepál one has to pass through the country of the following tribes:—the Koch, Bodo, Dhimál, Rábha, Hájong, Kúdi, Batar or Bor, Kebrat, Pallah, Gangai, Maráhi, and Dhanuk. The Rábha, Kúdi, Hájong, Mech, Gáro, and Páni-koch, are all affined to the Kachári or Bodo type. The last six of Hodgson's list are doubtful and undefined and require further investigation. The Dhimáls are found in the *sál* forest between the Konki and the Tarsa, mixed with the Bodos, but without intermarriage and living in separate villages. The Bodos extend from the Surma to the Dhansiri, and thence by Bijni and the Bhután and Sikkim Tarái to the Konki; besides occupying outside the forest limits a large proportion of central and lower Asám.[1] The Rábhás and Hájongs are found in the Gwálpára district and are Hindús, whilst the Páni-koch occupy the tract along the foot of the Gáro hills and are still pagans. The Dhimáls and some of the Bodos, Kochs, and Mechis are still pagans. The last-mentioned tribe is found all along the Tarái with the Kochs and Dhimáls. Their dialect and religion differ from those of the neighbouring tribes of the hills and plains. They are fairer than the Kochs and have strongly marked Mongolian features, but softer than those of the Lepcha or Limbu, resembling more the Newárs than the other hill-tribes of Tibetan origin. They live at elevations between 800 and 1,000 feet, and almost always keep to the forest, where they make temporary clearances. Their religion is connected with the Bhairava form of Sivaism. The Koch tribe is now nearly completely converted to Islám or Brahmanism, and with their conversion have dropped their old name and language, speaking a corrupted form of Bengáli, in which, however, many of the ancient vocables are retained. The Páni-koch, according to Hodgson, represents the unimproved primitive Koch stock; but Dalton considers them a plains tribe driven upwards by the Aryan invader. Hodgson estimates the number of all religions at over a million souls. The settled Koch assimilate in their food and clothing with the Bengális, and show no marked differences. The Bodo women wear garments of coarse silk, the produce of the worm that feeds on the castor-plant. The Bodo men and Dhimáls of both sexes wear cotton clothes. The men wear one cloth thrown over the shoulders and another wrapped round the waist and drawn up between the legs. The female garment consists of a cloth wrapped around the body and enveloping it from the arm-pits to the centre of the calves. Wooden sandals are worn, but ornaments are rare, though the women sometimes wear small silver rings in their noses and ears and heavy bracelets of mixed metal. Meat, fish, and vegetables are eaten by all, and beer made of rice or millet is a favourite beverage. Thárus and Denwars are found westwards in Nepál mixed with the Mechis, and especially the former in the malarious tract in the Gorakhpur and Tirhút Taráis along the foot of the mountains where no other human being can live. They, however, seem to be healthy, robust races.

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[1] See Hodgson's Aborigines of India, p. 151.

Karnáli to the Tons.

The mass of the people of the Doti district of Nepál and the British district of Kumaon belong to the race generically known as Khasas or Khasiyas. In Garhwál they are more mixed, though the difference is scarcely discoverable. The northern inter-Alpine valleys are, however, inhabited by Bhotiyas, who are decidedly of Tibetan origin. Amongst the Khasiyas there is a great admixture of immigrants from the plains, and most of the better classes look down with contempt on the purer members of the Khasiya class, who appear to represent the oldest inhabitants of these hills, though now much modified by centuries of close connection and intermarriage with the more civilized tribes of the plains. Throughout Kumaon, the Kyunam of the Tibetans, the inhabitants dress and eat like those of the plains, the only difference being that to the north woollen materials find more favour, and there is greater license in matters of food and drink. In Garhwál, which is known as Galdiya to the Tibetans and to the north as Chongsa, garments made of hempen fibre are common amongst the poorer classes. The language spoken throughout is pure Hindi, though for purposes of trade the Bhotiyas also use Tibetan, and amongst themselves speak a dialect of Tibetan origin. In the land of marsh and forests which borders the plains we find the Thárus in the eastern Tarái and the Bhuksas, a tribe of similar character, occupying the tract between Puranpur-Sabna in the Bareilly district and Chandpur in the Bijnor district. The Rájis in eastern Kumaon are akin to the Chepángs of Nepál, and the Lúls and Rawats of the same tract are now absorbed in the Hinduised population.

Bisahr.

To the west of the Tons we have a number of petty independent states known as the "protected hill-states," followed by British territory. Amongst the former the most important is Bisahr,[1] of which the northern part, called Kunawar, or more correctly Knaor, the Kunu of the Tibetans, marches with Tibet. The people of upper Knaor are of Tibetan origin and Buddhists in religion, and correspond to the Bhotiyas further east. Buddhism extends down the valley of the Satlaj as far as Sarahan, between which and Pangi is a sort of debateable ground common to Hindús and Buddhists; but north of Pangi Buddhism prevails, and south of Sarahan, Hinduism. With our approach to these Buddhist countries the curious custom of polyandry appears. Commencing in north-western Tihri, we trace it through Bisahr and Láhul, but find it confined to the inhabitants of the valleys of the central and higher ranges professing both the Buddhist and Hindu religions. The central tract is inhabited by a fair, slight, and muscular race of mixed origin known as Kunets, and akin to the Khasiyas on the east. To the south, in the portion adjoining the plains, the people resemble the inhabitants of the lower country, and appear of every shade of colour from dark-brown to a tawny yellow or yellowish-white. The hair is black and worn long at the sides and back of the head down about the ears, where it is cut short. The crown of the head is shaved bare, but moustache and beards are worn. The dress is a short coat of coarse cotton reaching to the knee, pleated in folds to give it fulness, and fastened round the waist by a girdle of the same material. A pair of cotton *páejámas* and a sheet of the same material complete the hot-weather costume. In winter these are exchanged for a pair of woollen drawers and a blanket, but the poorer classes remain content with a coarse waist-cloth and a blanket all the year round. The food of the people from the Káli to the Indus differs very little in each tract, or, indeed, from that of the people in the adjoining plains. Wheat, barley, rice, and various millets and pulses are grown in the lower hills, and to the north hardier varieties suited to a sub-arctic climate are cultivated. When the produce is insufficient for the wants of the inhabitants, a supply is imported from the lower districts. To the north, woollen home-spun replaces the cotton worn in the lower hills, and the girdle supports an axe. The women wear a similar dress, the coat reaching down to the ancles, and the hair, done up in long plaits, is twisted into rolls and covered with a piece of cloth wound like a turban round the head.

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[1] See section D. of references attached to this chapter.

Satlaj to the Indus.

To the west of the Satlaj we find the British territory of Kulu and Mandi, the independent state of Chamba, and the territories of Kashmír and Jamu.[1] Kulu, called in Tibetan Nyungti and Mandi, lies along the upper course of the Byás; Chamba, known to Tibetans as Panga, along the Rávi; and Láhul, the Tibetan Garzha, on the Upper Chináb. To the north in Láhul and Ladák the people are Bhotiyas or Bodpas of Tibetan origin, professing the Buddhist religion, and amongst them is a servile race known as Bem or 'low.' Further east in *Baltistan* are Tibetan Musalmáns who have adopted with their religion the Arabic alphabet. All these have decided Mongolian features, and are noted for their strength of body and power of enduring fatigue. In this respect the Baltis are somewhat inferior to their Buddhist brethren in race. The men wear a coat of woollen material reaching to the knees, fastened by a girdle, in which a knife is usually carried. Round their legs, from knee to ancle, they have coarse woollen leggings secured by a tape of the same material wound spirally round the leg from the ancle upwards. The head-dress is either a quilted skull-cap or a fur cap with the hair or wool inside, and with a large flap behind which covers the neck and ears. They wear boots of felt with soles of sheep or goat-skin. The women wear a black woollen jacket with a striped parti-coloured petticoat and baggy trousers, and over all a skin coat with the fur turned inside. The hair is arranged in a number of small plaits, and is ornamented by a band of cloth, on which is sown a number of turquoises and beads. The food of the common people consists of thick barley cakes, though those who can afford it eat wheaten bread and drink tea and a fermented liquor called *chang*. The name Kunet seems properly to designate only the mixed race in southern Knaor, but it is used for the population of the central tract in Bisahr, Kulu, Chamba, and Kashtwár, which borders on Ladák. In Chamba we find the Gaddis, who cross over into the neighbouring territory of Kashmír and meet the Thakars or Takkas, the chief cultivating class in those hills, and apparently in the same position with reference to other Hindús as the Játs of the plains. In the valley of Kashmír we have the Kashmíris, and amongst them the servile class called Bátal. To the south-west, along the left bank of the

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[1] See section E. of references attached to this chapter.

Jhelam, we have the Musalmán Dogras, called Chibhális, and the Musalmán Sadans of Púnch. On the right bank of the same river we have Musalmán Gakkars, Satis, and Dunds. To the east of the Chibhális come the Hindu Dogras, and amongst them the servile tribes of the Meghs and Dúms, who are scattered about everywhere and form a considerable part of the population. The Dogras have a light-brown complexion, clearly-cut features, and black hair, which is cut to form a fringe below the turban. The hair is worn on the face. The Thakurs are a well-made race, somewhat more powerful in body than the Dogra Rajpúts, whilst the Meghs and Dúms are darker in colour, smaller in limb, shorter in stature, and less bearded. The food and clothing differ in no marked respect from that of the hill-tribes at a similar elevation to the east. Passing to the north-west of the Kashmír valley we come upon the Dárds, an Aryan tribe called Brokpa by the Tibetans, and most of whom are Musalmáns, though the Dah section have adopted the Buddhist religion, language, and customs. They occupy Astor and the trans-Indus Kashmiri district of Gilgit, as well as the neighbouring Kanjúd states of Nagar and Hanza, and the Kashkára states of Chitrál, Yassan, and Mastúj. They are a strongly-built race, with decidedly Aryan features, wearing woollen garments, except among the higher classes, who wear cotton in summer. The ordinary costume consists of trousers, a coat reaching to the knees and confined by a girdle, and a cap of woollen cloth about half a yard long and turned up at the edges until it fits the head, the outward roll thus forming a protection against heat and cold. On their feet they have scraps of leather put under, over, and around the foot, and kept in their place by straps of the same material wound around them. A servile race is also found amongst them, known as Dúms, and performing the same duties as the Dúms of Kumaon. To the south-west of Kashmír, in the salt range, we find the Awáns and Janjúhas, tribes of Aryan origin and of considerable antiquity. From the Káli to the Indus, dialects of Tibetan are spoken to the north. Mr. Drew tells[1] us that from near the Nunkun group of peaks which form the water-parting between the Maru-wadwan and Suru rivers, "and from no other spot in Asia, one may go westward through countries entirely

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[1] Northern Barrier of India, p. 20.

Muhammadan as far as Constantinople; eastward among none but Buddhists, to China; and southward over lands where the Hindu religion prevails, to the extremity of the Indian peninsula."

Afghánistán, &c.

Amongst the great mountain groups comprising the western or trans-Indus extension of the Himálaya, and including the ranges known as the Hindu Kush, Kára-koram, and those connecting them with the Tian-shán, are several petty states, regarding which much has been learned of late.[1] To the south lies the country called Afghánistán, the north-eastern portion of which is included in the western prolongation of the Himálaya, while the south-western part is a mountainous country confluent with the Himálaya on the one hand and extending far in the opposite direction to the table-land of Persia. To the north the boundaries are ill-defined and vary almost from decade to decade. The authority of the ruler of Kabul, in many places, depends on the forces at his disposal to coerce his unwilling subjects; but in 1879, the Afghán province of Turkistán included the whole of the countries between the Hindu Kush and the Oxus, comprising Balkh, Kunduz, and Badakhshán, with their dependent states. The seat of the government is Balkh, with cantonments at Faizabad. Karátigin, on the upper valley of the Surkháb, pays tribute to Bukhára; also Darwáz, on the Panja branch of the same river, and Shignán-*cum*-Roshán, on the Ghund and Murgháb rivers. Wakhán is tributary to Badakshán, and south of it lies Kashkára, also called Chitrál. Northern Kashkára, including Yassan and Mastúj, is subordinate to the ruler of southern Kashkára, who resides at Chitrál. North of Gilgit we have the robber states of Hanza and Nagar or Kanjúd. South of Gilgit, in the valley of the Indus below Banji or Bawanji, are a number of small republics, who manage their affairs in assemblies called *sigás*, with which we may compare the similar institutions at the opposite extremity of the Himálaya. Some of these, such as Dárel and Hodar, owe a nominal subjection to Kashmír. Further south we come to the independent tribes of Buner and Swát. West of the Indus, in the Kunar valley, are the Bajaur and Dir states, and between them and the Hindu Kush range the country of Káfiristan.[2] It may well be supposed that this rugged tract, the meeting-place of the Turanian, Iranian, and Aryan races, presents many points of interest to the ethnographer as well as to the geographer; but here we can but very briefly refer to them, however important they may be.

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[1] See section F. of references attached to this chapter.

[2] Lately partially explored by Major Tanner, R.E.

Afgháns.

We have already noticed an Aryan race, the Dárds, occupying Gilgit and forming a part of the population of the neighbouring states. Here they meet the great Iranian race, which, under the name Tájik or Galcha, form the bulk of the cultivating population of the Musalmán states between the Indus and Jaxartes. History tells us that from the third century before Christ to the sixth century after Christ this tract was subject to the continued incursions of a Skythian race, traces of whom may be seen in the Brahúis of Biluchistán, the Hazárahs of the Hindu Kush, the Gujars there and in India, the Gakkars and Kohistánis of the Indus, and the Játs of India, and who have continued to influence the entire history of this tract to the present day. In the eleventh century the Afgháns were a small tribe in the Sulaimán mountains, of no importance and but little known. Since then they have increased so much as to have been able to annex a considerable extent of country, and to impose their language, Pukhtu or Pushtu, on the populations which they have absorbed. Along the Indus, Afgháns occupy the villages as far as Batera in 34° 53′ north latitude, where the Kohistán commences. The Afgháns themselves are tolerably fair, robust, and of moderate stature. They have long faces, high cheek-bones, and dark hair, which they wear unshaved. Their underclothing is of cotton, over which they throw a loose coat of woollen cloth, felt, or, more commonly, of sheepskin. They wear low caps on their heads, around which a cloth is twisted to form a turban. Boots are generally worn, and they carry a matchlock, scymitar, and shield. Leavened bread and meat are eaten by all classes. The women are rigorously secluded in the towns, but in the country, beyond the influence of the local maulvi or mullah, much more liberty is allowed. The use of wine is forbidden, but in the hills it is taken in secret, and that made in the Dárel valley has more than a local reputation. Pushtu approaches the Pehlavi or Zendic form of old Persian on the one hand, and the Sindhi form of Prákrit on the other. It is spoken throughout Afghánistán, and, with dialectal variations, in

Bajaur, Panjkora, Dír, and Swát. Afgháns are Sunni Muhammadans.

Kohistán, Kashkára.

The Kohistánis of the Indus claim an Arab descent and speak a language different from Pushtu and akin to Kashkári and Dárdui. They are fair and have sandy hair, and are of a robust make. They wear a tight-fitting coat and trousers resembling somewhat those of the European, with a cap of brown woollen material in the form of a bag rolled up at the edges. Around the legs and the feet a goatskin is wound, kept in its place by a strap of leather, the great-toe and the heel being left bare. A matchlock and sword are always carried, and they are expert shots. The women wear a loose jacket and trousers, and a cap of cotton or wool, over which they throw a woollen or cotton sheet when proceeding far from their villages. Unleavened bread of wheat, barley or millet *(Holcus sorghum)* is eaten with vegetables, milk, butter, or stewed meat. Further north the people are less prosperous and more regardless of cleanliness. In some of the villages there are colonies of pastoral Gújars, and in the Yassan villages settlements of Dúms, who supply the musicians and dancers of the country. Following next the Kunar valley, we have dialects of Pushtu spoken in Bajaur and Dír as far as the Lahori pass leading into Chitrál. Here it meets the Kashkára, which is akin to the Dárdui and is of Prákritic origin, though many Persian vocables have been added. The pagan inhabitants of Káfiristan are of the same race as the Kashkáras and the Dárds, and speak a language having an archaic Prákritic origin.

Galcha states.

Moving further westward into Badakshán, we come amongst a large Iranian population speaking Pushtu in the south and Persian in the north, and from Narín an Uzbeg population speaking Túrki, and the nomad Hazárahs having a dialect of their own. On the invasion of the Turks the old inhabitants retreated into the more inaccessible valleys of the great ranges, and there founded the Galcha states of Darwáz, Karátigin, Shighnán, and Wakhán. In Darwáz and the adjoining parts of Badakshán pure Persian is spoken or understood. The vocables and grammar of the Galcha proper show a strong affinity to Dárdui, and many conjecture that, in its pure state, it must have been the intermediate link between the Iranian and Indian branches of the great Aryan family; that the dispersion took place from the '*bám-i-dunya*,' 'the roof of the world,' the Indian branch proceeding southwards and along the Kábul river to India, whilst the Iranian branch crossed the Pámír to the plains of Turkistán. Towards the plains the Galchas are Sunnis, but in all the hill districts, except Darwáz, they are Shiáhs. The Shiáh is held in the same contempt as the infidel, and the Sunni esteems it a holy and righteous act to capture and sell his less orthodox fellow-believer into slavery. Amongst the tribute paid by the hill states to the Afghán governors of Badakshán and to the Wali of Bukhára, not the least important parts are the troops of fair-complexioned girls from the upper valleys of the Galcha states, and, when procurable, pagan boys from Káfiristán. Uzbegs are chiefly found in the country, and Tájiks in the towns along the plains below Badakshán and in Turkistán; the former invariably speak Túrki and the latter Persian, or dialects with a number of Persian words in them. In Wakhán the men wear brown woollen coats and trousers, Ladáki boots, and a scanty cotton turban, either blue or white. The women here also dress much like the men, and, as in Chitrál, wear their hair in long plaits. They have Jewish noses and are not very fair-looking. Kirghiz are found along the eastern slopes of the Tian-shán and the northern slopes of the Pámír and Kuen-lun ranges in Chinese Turkistán. The Alai Kirghiz of the Pámír have a bad reputation as robbers. East of them lie the great uninhabited steppes until we come to the country near Kanjúd, which is rendered unsafe by the raids of the people of Hanza and Nagar. Further east we have the Chang-thang highlands, occupied by the robber Bhotiya tribes of Changpás, speaking a Tibetan dialect akin to Zanskári. The dress of the male Kirghiz inhabiting the pastoral slopes of the highlands south of Yárkand and Káshgar is not different in any material degree from that of the other inhabitants.[1] Their women wear as a head-dress a white cloth rolled evenly and regularly round a skull-cap of red or other bright material, with lappets over the ears. The end of the turban is drawn down and passed over the lappets and under the chin, and the coat worn is a dressing-grown of wadded and quilted cotton. In the plains the winter dress of the females comprises a fur cap of black lamb's wool with a trimming of the fur, and a crown of coloured silk or cloth worn over a square of muslin which forms a veil. The coat worn is full and long, and the boots are of embroidered leather with high heels. The hair is worn either in two long plaits or in ringlets. The men wear a close-fitting cap lined with fur and turned up at the bottom. The coat resembles that worn by the women, only it is fastened by a cotton girdle, and the boots are worn long and plain, with felt stockings. In winter, sheepskin with the wool attached is the universal material for clothing.

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[1] Gordon: Roof of the World.

Kára-kurchins.

To Prejevalsky we are indebted for an account of the people around the lake country of the Tarim near Lob-nor, to the north of the Altyn-Tágh, and of those inhabiting the eastern extremity of the Kuen-lun near the sources of the Hoang-ho. The former[1] present "a strange mixture of facial types, some of which call to mind a Mongolian race. The prevailing characteristics are, however, Aryan, though far from pure. * * In height they are rather below the average; frame weak and hollow-chested; cheek-bones prominent and chin pointed; beard scanty and *à l'Espagnole*; whisker even smaller; hair on the face generally of feeble growth; lips often thick and protruding; teeth white and regular and skin dark, whence their name Kára-kurchin may be derived." Their language is said to resemble closely the dialect of Khoten. The clothing of the lake-dwellers is made from the fibres of a species of *asclepias*, and consists of a loose coat and trousers with, in winter, a sheep-skin cap, and in summer one made of felt. In summer the feet are uncovered, and in winter shoes of untanned hide are worn. The coats in winter are lined with duckskins dressed in salt. Fish, wild-fowl, and the tender shoots of reeds are their principal food. All profess the Muhammadan religion.' The inhabitants of the country along the Tarim towards Korla appear to be also of the same race, though comparatively more civilised.

Tára-Tangutans.

To the north-east, towards the Yellow river, we have the Kára-Tangutans, a race apparently connected with the Tibetans proper. They are more robust in form, greater in stature, and darker in complexion, than the Tangutans of Kan-su. Their hair is black, but the head is shaved clean and no pig-tails are worn. The eyes are dark and large, never narrow like the Mongols; the nose straight and sometimes aquiline and also sometimes *retroussée;* the lips thick and protruding; the cheek-bones not so prominent as in the Mongol; the face long and never flat, and the skin tawny coloured. The language is akin to Tibetan. The dress in summer comprises a long, grey, woollen coat reaching to the knees, boots, and a low-crowned, broad-brimmed, felt hat. In winter a sheepskin coat is put next the skin, and the upper part of the legs is usually left bare and also the right arm and part of the right breast, the right sleeve being allowed to hang down empty. The women dress like the men, and all live in tents made of black, coarse, woollen cloth, whence the name Kára (or black)-Tangutans. They are met as far as the Murui-ussu, the extreme point reached by Prejevalsky.[1] Of the people between the Hoang-ho and Brahmaputra very little is known beyond the fact that they are of Tibetan origin and chiefly Buddhists in religion. Pamutan near Bathang, which lies in about 99° east longitude and 28° 50′ north latitude, is the most westerly point attained by Mr. Cooper[2] in his memorable journey from Hankow towards the frontier of India in 1868; and Prun, in the Mishmi country, the most easterly point reached in his attempt to penetrate the intervening ranges to China in 1870, leaving a space of about 120 miles as the crow flies unexplored and unknown.

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[1] From Kulja across the Tian-shán to Lob-nor: London, 1879, pp. 44, 166. See, further, section G. of references attached to this chapter.

Tibet.

We have now briefly sketched the character of the countries and peoples encircling the great elevated area which from Ladák on the west to the Chinese frontier is known as Tibet, and is entirely under Chinese influence. The true name of this tract is Bod-yul or Bod-land, and the people Bod-pas, corrupted by the Indians into Bhotiyas, a name now applied to the Tibetans living on the borders between India and Tibet, whilst the people of Tibet proper are called Huniyas and the country Hundes. The eastern division of Tibet is known as Khám or Khám-yul, sometimes called Bod-chen; it extends from the frontiers of China to about 95° east longitude. Central Tibet or Tibet proper is called Bod at its eastern end, and

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[1] Mongolia, by Prejevalsky: London, 1876, II., pp. 109, 301.

[2] Travels of a Pioneer of Commerce in Pig-tail and Petticoats: London, 1871.

g-Nári or Nári at its north-western end; the former division being the shorter of the two, but perhaps broader and more civilised and populous. A line drawn from Darjíling northwards would apparently separate Bod from Nári. The central part is also called U-Tsang from the two provinces of U and Tsang in which Lhása is situated. Nári is divided into the three great districts of Mang-yul, Khorsum, and Mar-yul.[1] The first marches with Nepál almost to its western boundary; the second extends along the British frontier of Kumaun and Garhwál and that of the independent state of Bisahr; and the last included western Tibet and the Kashmíri states of Balti and Ladák. The physical characteristics of this tract have had the effect of isolating its inhabitants, who are distinct in race and language, from all the nations we have described, and find their affinities in the Tangutans of the north-eastern Kuen-lun already noticed. They are broadly built; have dark hair, scanty beards, high cheek-bones, oblique eyes, complexion fair amongst the better classes, dark amongst the lower, who are more exposed to the weather. To the east in the warmer valleys they are agriculturists, and to the west and north follow a pastoral life. The costume varies in the different provinces and with the means of the person, but as a rule the men in the wilder parts shave the head clean like the Kára-Tangutans, whilst the more settled allow it to grow long and plait it into a queue or tail like the Tangutans proper. To the east Chinese fashions are in vogue, and to the west the common dress is a coat and trousers of undyed woollen material with boots to the knee. The Lamas wear distinctive dresses, red or yellow according to the sect to which they belong, and the wealthier indulge in coloured broad-cloth garments of English or Russian manufacture. Barley porridge, tea and meat form the staple food of the people, and *chang* or beer, a simple infusion of malted barley, is of universal use all over Tibet.

General distribution.

Having completed our review of the nations inhabiting the Himálaya and the surrounding country, we may now briefly notice the natural distribution of the several great races that have come under our consideration in the special tracts that each now occupies. The extraordinary rigour of the climate and the physical barrier that exists between Tibet and India sufficiently explains the absence of ethnical or political relations between the two countries. Accident has given the Indian state of Kashmír political preponderance in western Tibet, but the ethnical distinction still remains, and will probably ever continue. The climatic condition of eastern and northern Tibet allows of a free migration of the inhabitants from one part to the other, which is shewn in the common origin of the people of those countries to the present day. Turks and Tartars occupy the country called Turkistán, similar in character to their original homes; but in proportion as the climatal conditions become Indian, so does the population become Aryan. The Tartar is the child of the rugged bleak steppes; and when we approach the cold and wooded mountains we come on the Hindu element at its maximum in the tract around the sacred sources of the Jumna and the Ganges, gradually diminishing as we move eastward towards the excessively moist though warmer valleys of the Nepál and Asám Himálaya, where they are replaced by races akin to the people of eastern Tibet and Siam, and on the west meeting the Iranian and the Tartar in the trans-Indus ranges. To the north of the Kuen-lun the Mongol and Chinese converts to Muhammadanism, called Tunganis, and in western Tibet the Muhammadan Baltis, divide the Buddhists from the followers of Islám. In the valleys of the affluents of the Oxus and the Kábul river we have an Iranian race of Galchas or Tájiks driven upwards by political disturbances and mixing with an indigenous mountain race of Aryan extraction. The rigorous climate and scanty cultivation which prevents the intrusion in any numbers of a southern race also debars the tribes inhabiting the higher hills from making any permanent occupation of the lowlands. Like their favourite domestic animal the yak, the Himálayan mountaineers do not thrive at low altitudes, nor can plains-bred men or animals withstand for any time the arctic cold and rarefied air of the more elevated regions. Thus, there is a clear connection between the distribution of the nations that are found in the Himálaya and the physical characteristics of the regions that they occupy; and if we had time to pursue the subject further, it might be shown that the orographical conditions of a tract have materially influenced its history, political and religious, and the social and moral character of its inhabitants. The disposition of a people towards peace or war; their migrations; the diffusion of their language; their habits, pastoral, agricultural, or commercial; the extent of their influence—all depend more or less on the physical peculiarities of the country that they inhabit. And not only is man so affected, but the entire fauna and flora obey the same laws, so that the skilful naturalist can from a plant or even a butterfly describe the general character of the country of which it is a native, and with it the customs and manners of the inhabitants. For the nature of a country, whether mountainous or level, the direction of the great ranges, the length and line of coast, the position with regard to the equator, the relations of land and water, and the drainage systems, are all primary agents in the distribution of organic life and of the influences which govern all atmospheric and climatic phenomena.

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[1] From Captain Henry Strachey's paper on the physical geography of Western Tibet, London, 1854, still our best authority on the subject. A more detailed account will be given hereafter in the Gazetteer portion of this memoir: see also section H. of references attached to this chapter.

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CHAPTER II.

PHYSICAL GEOGRAPHY OF THE HIMÁLAYA.

CONTENTS.

The Himálayan river basins—The Indus basin—Subordinate systems of the Indus basin; The Ganges basin—Subordinate systems of the Ganges basin; The Brahmaputra basin—Subordinate systems of the Brahmaputra basin; Systems of Tibet—Lob-Nor basin; Oxus basin. Plains of Hindustán—Indus plain; Indian desert; Gangetic plain; Asám valley; Bhábar; Tarái; Siwáliks; Dúns. Extent of Bhábar—Cause of the deposit—Hodgson's oceanic theory; Fluviatile theory; Tarái; Siwáliks; Dúns; Ganges to Brahmaputra; Lower Himálaya. Materials of the mountains—Eocene period: Mode of mountain formation; Mountain-sculpture; Ice-wedges; Avalanches; Glaciers; Rain; Rivers.

The Himálaya.

We have already decided to restrict our use of the word 'Himálaya' to that portion of the great mountain girdle which lies between the bend of the Indus on the west and the unexplored gorge of the Brahmaputra on the east. Hodgson, in 1849, estimated the length of this range at 1,800 miles with a mean breadth of about 90 miles, a maximum breadth of 110 miles, and a minimum breadth of about 70 miles. In fixing the breadth of the Himálaya, however, as in determining its length, we have similar difficulties to contend with. For, as we have seen that the popular estimate as to the boundaries of the range may possibly be correctly extended both on the east and on the west, so on the north, the channels of the Indus and the Brahmaputra, which are commonly assigned as the northern limit, are found in a plateau, but little lower than the passes by which the traveller crosses the first line of snowy mountains into Tibet. On the south, we have a well-marked descent to the plains of India, but on the north there is no immediate descent to a lower country beyond. On the contrary, range after range is met with to the north, many of which may compete in altitude with the snowy mountains seen from the plains of northern India.

River-basins.

Before proceeding to a closer examination of the form of that portion of the Himálaya lying within the province of Kumaon, it will be convenient briefly to describe the river-basins throughout the Himálaya and endeavour to trace the general law underlying their arrangement. For as this depends in the main on the direction of the great ranges and the position of the great peaks, a consideration of it will conduce to a clearer apprehension of the entire mountain system itself as well as of the relations of its various parts. We find that from a water-parting about longitude 81° east and almost immediately due north of Kumaon, the drainage of the southern part of the Tibetan plateau flows north-west in the Indus and south-east in the Brahmaputra. These two rivers maintain a course along the length of the table-land, and receive as they proceed the drainage of a large part of its breadth; the exceptions being, first, the eastern border, which apparently is drained by the Lu-tse, the Lan-tsang, and the Murui-ussu, one of the sources of the Yang-tse-kiang;[1] second, an occasional strip along the southern edge from which the water passes off[2] more or less directly to the south through the Himálaya; and third, the north-western part from which the water has no escape, but is collected in lakes at the lowest level it can reach.[3] The waters thus accumulated in the two great streams are at length discharged by two openings in the Himálayan slope through the plains of India into the Indian Ocean. No great portion of the drainage of the table-land, so far as we know, passes in the opposite direction through the northern slope, and the area that discharges itself southward at points intermediate between the debouches of the Indus and the Brahmaputra is with one exception, that of the Satlaj, comparatively small. The waters of the northern slope with a small area of the table-land adjoining flow down to the plains of eastern Turkistán: while, in like manner, those of the southern slope with the drainage of the exceptional area along the southern border of the table-land which passes through the line of water-parting from the north, give rise to such rivers as the Jhilam, Chináb, Ravi, Jumna,

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[1] From Prejevalsky's Mongolia (London, 1876) it would appear that his Burkhan Buddha range marks, in 96° longitude, the north-eastern termination of the Tibetan plateau. This range forms the southern boundary of the Tsaidam plain, which, according to native report, extends thence to Lob-Nor. The Nomokhun-gol, which rises on the southern face of the Burkhan Buddha range and joins the Baian-gol, does not appear to be a feeder of the Hoang-ho or Yellow River, which has its origin outside the Tibetan plateau. To the south of the Burkhan Buddha range the elevation is from 13,000 to 15,000 as far as the Murui-ussu, the bed of which, where seen by Prejevalsky, was 13,000 feet above the level of sea with a channel 750 feet broad in January. The name 'Murui-ussu' signifies 'the tortuous river,' and, according to Yule, it is the Bri-chu of the Tibetans, the Brius of Marco Polo, and the Yang-tse-kiang or Blue River of the Chinese.

[2] By the Satlaj, Karnáli, and Arun.

[3] Examples of river-systems without an outlet to the seas are to be found in the basins of the Caspian, Aral, Balkhash, Lob-Nor, &c.

Ganges, Káli, Gandak, Kosi, and Tísta. We thus see that the northern crest of the table-land or the summit of its northern slope practically forms the water-parting between the rivers that flow southwards and those that lose themselves in the plain of Gobi. In the southern crest we have a subordinate water-parting separating the rivers that fall into the Indian Ocean into two classes; first, those that rise on that slope and flow directly down it to the plains of Hindustán; and secondly, those that are collected along the table-land and are finally discharged also through the southern slope, chiefly by two concentrated channels at distant points towards the ends of the range. Captain Henry Strachey[1] has called the northern crest of the table-land the Turkish, and the southern the Indian water-parting.

Indus basin.

If we examine the river-systems having their source in the Himálaya, we find a regularity of plan and arrangement which at first sight would not be expected. Taking the Indus basin and its system, we see that the Satlaj and all the rivers that join the Indus on its left bank have a south-westerly direction towards the Arabian Sea. On the east this system is bounded by the small inland basin of the Kaggar, which receives the drainage from an inconsiderable portion of the outer hills between the Satlaj and the Jumna, and finally loses its waters in the Indian desert. The eastern water-parting of the Indus system is found in the elevated range extending from the main Himálayan mass along the left bank of the Satlaj to Rúpur, and is continued thence in the uplands bordering the *khádir* of that river until it meets the Arvali (Aravali) range which constitutes the north-western abutment of the table-land of Central India. The character of the slope towards the south-west will be best understood from the following table of heights taken along the course of the Satlaj to Ludhiána, and thence by the Grand Trunk Road to the Jumna :—Táru, about two miles below the junction of the Panjnad and Indus, 337 feet above the level of the sea ; Baháwalpur, 375 feet ; Núr Sháh, 481 feet ; Pír Khális, seven miles north-east of Baháwalgarh, 548 feet ; Fazilka, 588 feet ; Firozpur cantonment, 645 feet ; Jagraon, 765 feet ; Ludhiána, 806 feet ; Amballa Church, 899 feet ; and Madalpur, on the banks of the Jumna khádir, 906 feet. From Sodiwála in the Firozpur district southwards on the 75th meridian we have Sodiwála, 718 feet; Ahmadwála, 705 feet; Sirsa, on a mound, 737 feet; level of Sambhar lake, 1,184 feet.[1] These observations show a slight depression towards the south in addition to that towards the south-west, and would make us include the Kaggar inland basin in the Indus system. The Sotra or Hakra, the ancient river of the Indian desert, seems, however, to have once had its debouche in the Ran of Kachh,[2] and would therefore be still entitled to be considered separate. To the west the Rávi and the Chínáb run in lines almost parallel to the Satlaj, as well as the Jhilam, from the town of that name, until it takes a bend to the south to its junction with the Chínáb. To the west, the water-parting of the Indus commences at Cape Monze on the Arabian Sea, and advances nearly northwards along the Hala mountains to the east of Sohráb, Kalát, and Quettah (Kwatah). It thence continues in the same direction along the western Sulaimán range, also known as the Konak, and Kúb Jadrán range to the Safed-koh, at the head of the Kurram valley. Thence it follows the crest of the Safedkoh westwards to the hills north of Ghazni, where it separates the southern affluents of the Kábul river from the waters of the small inland basin of lake Abist'ida. The direction is then continued north-westerly to the ridge separating the head-waters of the Argand-áb from those of the Kábul river, and again in the range that separates the waters of the Halmand basin from the most westerly affluents of the Kábul river, whence a transverse ridge near the pass to Bámian connects the line of water-parting with the Hindu-kush. For 300 miles the line follows the Hindu-kush to its junction with the great Tághdambásh Pámír near the Baroghil pass. It then follows the Muztágh range,[3] but cuts through it around by the Kárakoram pass to the north, so as to include the tributaries of the Shayok, and proceeds in a south-easterly direction by the Aling Gang-ri to its junction with the Gang-ri at Kailás, where a transverse ridge separates the head-waters of the Indus, the Brahmaputra, and the trans-Himálayan feeder of the Ganges system. The Indus has a length of 1,800 miles, and, according to Mr. Saunders, its basin has an area of 372,000 square miles.

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[1] J. R. G. S., XXIII., p. 7.

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[1] G. T. S. tables.

[2] See Notes on the lost river of the Indian desert, Cal. Rev., July, 1874.

[3] 'Ice-mountain': a better name than Kárakoram (black-gravel), which should be restricted to the pass.

Subordinate systems of the Indus basin.

The Hala mountains to the south of the Mula pass are better known as the Khirthar hills and as the Pubh hills, and the drainage from them loses itself in the plains before it can reach the Indus. The same may be said of the drainage through the Mula and Bolan passes, and that by the Thal valley. To the north, the Luni, Gomal, Kurram, and Kábul rivers, each possessing a perennial stream, have an easterly course more or less parallel to each other, and break through the range bordering the right bank of the Indus by deep and narrow gorges which form the passes into the upper country. The Kábul river itself is the drainage channel for the very elevated country from the hills north of Ghazni to the Baroghil pass north of Chitrál, and from Naushera to the pass leading to Bámián, and thus forms a compact subordinate system well deserving of separate study.[1] The upper waters of the Jhilam drain the Tile and Kashmir valleys, and have a general direction between west and north to Muzaffarabad, where they unite, and, meeting a meridional ridge, take a bend southwards to the plains. The Chínáb, in the upper portion of its course known as the Chandra, has a similar direction between west and north until it meets the spurs from the range which forms the water-parting between it and the Jhilam, whence it seeks an outlet southwards towards the plains. The Ravi runs in a valley parallel to that of the Chínáb and south of it until it meets the outliers of the range that forms the water-parting between it and the Chínáb, when it also turns suddenly southwards towards the plains. Next comes the Biás, which has also a westerly direction until it meets the ridge between it and the Ravi, when it takes a bend to the south through the outer hills. The upper course of the Satlaj has a similar westerly trend until it meets the great obstruction culminating in the Leo Porgyul peak, after which the direction is between west and south until it enters the plains. A range runs between the Satlaj and the southern branch of the Indus from the meridian of Tirthapuri by Gár, to where it is joined by the ridge connecting it with Leo Porgyul, and thence into Rupshu to the north of the Tso Moriri lake, and constitutes the subordinate water-parting between the Satlaj itself and the

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[1] For interesting articles on the tract between the Arabian sea and the Gilgit river, by Mr. C. R. Markham, see Proceedings R. G. S., 1879: the mountain passes on the Afghán frontier of British India, p. 38; the upper basin of the Kábul river p. 110: the basin of the Helmund. p. 191.

Indus. Thus we see that the great feeders of the Indus system from the west have a similar character, and that those from the east, from the Himálaya proper, have a general westerly direction, in the upper portions of their courses in the hills, until they turn southwards towards the plains, where the direction is south-west to their junction with the Indus.

The Ganges basin.

Next we have the Ganges basin with its subordinate systems. To the north, the water-parting, as a rule, follows the ghát-line of the Himálaya and on the extreme west separates the sources of the Jádh-Ganga, one of the head-waters of the Bhágirathi, from the Hop-gadh, an affluent of the Satlaj. North of Kumaon, however, we have a phenomenon similar to that observed near the Kárakoram[1] pass, where the waters of the Shayok, Yárkand, and Kárakash rivers have a common origin in that elevated plateau at no great distance from each other. We find that to the east of the Unta-dhúra pass, north of Milam in Kumaon, the water-parting of the Ganges basin crosses to the north of the ghát-line to a place called Tara, where the sources of the Satlaj and the Karnáli lie close together, "divided by an almost level plain, across which a man might walk from one river to the other in an hour or two, without a vertical ascent or descent of 500 feet," yet the waters of one stream seek the sea at Karáchi, and of the other by Goalundo. Further east the water-parting is continued in the ghát-line to the Arun river, which has its sources to the north and forces for itself a way through the Himálaya to the plains. The water-parting then follows the eastern boundary of Nepál to the plains, where an intricate system of drainage is met with, throwing off feeders sometimes to the Brahmaputra and sometimes to the Ganges down to their junction at Goalundo. Following the line on the west from east longitude 79° 11′ and north latitude 25°, we find in the extreme north-west that the water-parting keeps to the crest of the range running along the left bank of the Baspa, an affluent of the Satlaj, and is continued by Hattu to the ridge on which Simla is built. Thence it proceeds southward, and then eastward along the right bank of the Giri to the junction of that stream with the Jumna near Rájghát. Here the water-parting turns southwards along the line separating the drainage area of the Kaggar system from that of the Jumna, and continuing along the Arvali range and the edge of the Málwa plateau, passes through the Jabalpur and Mandla districts, separating the sources of the Nerbudda from those of the Son, and then along the range connecting the Sátpuras with the Rájmahál hills to the plains, where it follows a course along the left bank of the Sabanreka to the sea. Mr. Saunders has given the length of the main stream of the Ganges as 1,514 miles, and the area of its basin at 391,000 square miles.

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[1] Dr. Scully describes the appearance of the country between the top of one of the Shayok gorges and the Kárakoram pass thus :—"At the top of the ascent a strange sight met our eyes, for we found ourselves on an immense undulating plain, the Dipsang, which looked like the top of the world. * * Northwards, in front of us, we saw a few irregular flat-topped hillocks, they looked like scattered about * * I had occasion to look back in the direction of the route by which we had come. A fine snowy range of mountains met my view and looked quite continuous; but, of course, this was a deceptive appearance, as we had passed through this chain without crossing any pass." This was the Mustágh range, whilst the Kárakoram pass, distant about 25 miles ahead and forming the water-parting, lay amongst the seeming hillocks, a fact which shows that though a range may form a water-parting, a water-parting does not always form a part of a range. Colonel Gordon gives views of the Kárakoram pass in his 'Roof of the World.'"

Subordinate systems of the Ganges basin.

The Ganges basin, like that of the Indus, possesses several subordinate systems that may be called in their order from west to east, the Jumna-Ganges, Karnáli, Gandak, and Kosi systems. The alpine basin of the Jumna-Ganges system is bounded on the west by the well-defined range which descends from the Jamnotri group of peaks to the Satlaj river, and on the east by a similar ridge descending from the Nanda Devi group of peaks and separating the waters of the Pindar from those of the Himálayan Sarju. To the north, the ghát-line separates it from the source of the Karnáli on the east, and the source of the Satlaj on the west. Although the upper waters of both the Jumna and the Alaknanda, or principal source of the Ganges, have at first a westerly direction, they soon take a bend to the south, and form the main channels to which are directed their affluents from either side. It is remarkable that, with the exception of the Rámganga, which unites with the Ganges in the Farukhabad district, neither the Jumna nor the Ganges before their junction receives any considerable affluent of Himálayan origin during its course through the plains. The western boundary of the alpine basin of the Karnáli is marked by the ridge extending from the Nanda Devi group between the Pindar and Sarju rivers, already noticed. The eastern boundary is formed by a similar ridge descending from the Dhaulagiri group of peaks. To the west the Sarju, eastern Rámganga, Gori, and Káli enter the plains in one stream as the Sárda. Then the Swetaganga Karnáli, and Bheri form the Karnáli, and further east we have the Jhingrak or Rápti and its affluents. All unite in the plains to form the Ghogra, which joins the Ganges to the south of the Gházipur district. But this unitising law is better exemplified in the alpine basin of the Gandak, which reaches from the Dhaulagiri group to the Gosáin-thán group of peaks. We have here seven rivers named in order from west to east, the Barigár, Naráyani, Swetigandaki, Marsyángdi, Daramdi, Burhiya-Gandaki, and Trisúl-Gandaki. These are called the seven Gandaki by the Nepálese, and unite their waters at Tribeni within the hills to form the Gandak river of the plains. Here we have what Hodgson[1] terms an admirably defined natural division lying between two great groups of peaks. In the same manner as the Karnáli basin is bounded on the west by the spur descending from the Nanda-Devi group of peaks, and on the east by the ridge from the Dhaulagiri group, so the Barigár of the Gandak system does not receive a single streamlet from the westward of the Dhaulagiri ridge, nor does the Trisúl of the same system receive any water from the east of the ridge descending from Gosáin-thán. The alpine basin of the Kosi lies between the Gosáin-thán group and the Kanchinjinga group of peaks, and, like the Gandak system, consists of seven rivers,[2] known as the seven Kosis. These, named in their order from west to east, are the Milamchi or Indrawati, the Bhotiya-Kosi, Támba-Kosi, Likhu-Kosi, Dúd-Kosi, Arun, and Tamra or Tamor. The Arun has one of its sources to the north of the line of snowy peaks seen from the plains, and the Tamor is also said to have trans-nivean affluents, but all the others rise on the southern slope of the Himálaya, and unite within the hills at Varáha-Kshetra above Náthpur. The subordinate systems of the Ganges basin thus appear to be strongly characterised by a common origin within an area bounded on the north by the ghát-line, and on the west and east by well-marked groups of culminating peaks, whence ridges descend and form the water-parting between successive systems.

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[1] See his article on the Ganges basin, J. A. S., Ben., XVIII., 761. [2] *Ibid.*, XVII., ii., 646.

Brahmaputra basin.

The Brahmaputra basin in its full extent has not been explored, but sufficient evidence has been collected by recent travellers to show that from the water-parting between the sources of the Brahmaputra and the Indus, the northern water-parting of the former river continues in a range of lofty peaks on its left bank to the bend towards the south, by which it reaches the plains of India. This range has a direction south-east, and to the west of the 86th meridian is sufficiently distant from the Brahmaputra to allow of such affluents as the Chachu and the Charta rivers. About the 86th meridian, a line of peaks culminating in the Tárgot La stretch in a north-easterly direction to the Gyákhárma group of peaks, south-east of the Kyáring-cho or Kyáring lake, one of the sources of the Nák-chu-kha. The drainage of the southern slope of the range is sent by the Dumphu-chu into the Kyáring lake, so that the northern water-parting of the Brahmaputra must here approach much closer to the river and run in a south-easterly direction. On the 89th meridian, it descends as low as the 30th parallel in the Shiang Lahu range, which appears to be connected with the great Ninjin-thángla range of snowy peaks to the south of the Jáng Namcho or Tengri-Nor lake with a trend to the north-east, for it gives the head-waters of the Ki-chu or Lhása river from its southern slope, as well as other important streams further east, regarding which our information is still very imperfect. To the north-east we find the Nák-chu-kha or Hota Sanpo, a large river that issues from the Chargut lake about north latitude 32° and east longitude 89°, and flows eastward, having its drainage area on the south, bounded by the water-parting between it and the Brahmaputra basin. This great river takes a bend to the south, and according to one of the Pandit explorers,[1] flows by Tsiamdo on the road from Lhása to Bathang, and thence through Amdu to China, under the names Máchu and Konkong. These names would connect it with the Yang-tse, but if it flows by Tsiamdo it should be one of the branches of the Lan-Tsang, the name of the upper portion of the Mekong or Kambodia river. Des Godins notes that the Nu-Tse or Lu-Tse is known as the Ngen-kio in Tibet, a name which may perhaps be referred to the Nák-chu, and it would then be the head-waters of the Salween, whilst others claim it as the source of the Irawadi. All that can, therefore, be said is that there is a great river in eastern Tibet, between which and the Brahmaputra is an unexplored tract of country, and within it will be found the eastern water-parting of the Brahmaputra. So far as we may conjecture from the imperfect materials at our command, the range that forms the northern water-parting of the Brahmaputra takes a sudden bend southwards between the 96th and 97th meridians along the right bank of the Lu-Tse. Thence one branch proceeds westwards in the Patkoi range, and another southwards, between the Irawadi and Salween. To the south, the water-parting follows the crest of the Patkoi range, and is continued westwards in the Manipur, Lushái, and Chittagong hills, where it separates the southern affluents of the Brahmaputra from those of the Barmese systems. To the west, the water-parting is conterminous with that of the Ganges basin. Mr. Saunders estimates the course of the Brahmaputra at 1,800 miles, and the area of its basin at 361,000 square miles.

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[1] G. T. S. Rep., 1873-75, p. 68. The *Athenæum* of the 17th April, 1880, announces the arrival of Colonel Prejevalsky at Nák-chu-kha, about twelve marches north of Lhása, and we shall doubtless obtain some solution of the problem connected with this river from this great traveller.

Subordinate systems of the Brahmaputra basin.

Following the systems that carry off the drainage from the southern slopes of the Himálaya and join the Brahmaputra in its course through the plains, we trace much the same regularity found in the subordinate systems of the Ganges basin further west. The Tísta system of Sikkim is bounded on the west by a ridge descending from the Kanchinjinga group of peaks, and on the east by a similar ridge from the Chumalári group that also forms the eastern boundary of Sikkim. The alpine rivers of this system in order from west to east are the Bári Ranjít, Ratong, Lachen, Lachung, and Rang-chu, and all unite within the hills above Kalingpong to the east of Darjiling. The alpine basin of the Tarsa-Gangadhar system extends from the Chumalári group on the west to the ridge descending some fifteen miles east of the 90th meridian in the 28th parallel, and which separates the waters of the affluents of the Tarsa from those of the Manás system. The rivers of this alpine basin from west to east are the Ammo, Dor, Par, W ang, Ma, Pachu, and Tanchu, which unite within the hills to form the Tarsa and the Gangadhar tributaries of the Brahmaputra. Further east comes the Manás system, of which the western water-parting is conterminous with that of the Tarsa-Gangadhar system. On the east, it is bounded by a ridge descending from the group of snowy peaks to the west of the Karkang pass crossed by the Pandit on the Táwáng route in 1873, and for its alpine feeders has the Mati, Manás, Kuru, Lhopra, and Táwáng streams, which apparently also unite within the verge of the mountains to form the Manás. Eastwards lies the Subansiri system between the Manás and the Dihong. The Sikang-chu, which rises to the south of the Karkang pass, probably forms one of its sources, but the remainder lie within the wild country of the Abors and have not yet been explored. The southern affluents of the Brahmaputra during its course through the valley of Asám are not so important, and may be divided into two classes—those which carry the drainage of the northern slope of the hills inhabited by the Singpho, Aror, and Nága tribes, and fall directly into the Brahmaputra, and those which carry the drainage of the northern slope of the hills of the Lushái country and hill Tipura and of the southern slopes of the Jaintiya, Khasiya, and Gáro hills to the Megna, which joins the Brahmaputra below Dakka. To the former class belong the Dihing, Disung, Southern Dhansiri, and Kopili, and to the latter the Barak, Súrma, and Dhani.[1] To the extreme east of the Asám valley is a snowy range from which issues the Lohit or Brahmakund river that gives its name to the Brahmaputra; but geographers have applied the same name to the great river flowing by Lhása, and which the best authorities identify with the Dihong that joins the Lohit in the upper valley of Asám. The more general name of the Brahmaputra, in the upper portion of its course, seems to be 'Tsanpo' or 'Sanpo,' meaning 'the river' or 'the great river,' used like 'Ganga' in the plains and 'Kiang' in China. In Asám, the name varies with the tribe inhabiting its banks or those of its tributaries, so that the designation 'Brahmaputra,' to express the entire course of the river from its source to the north of Kumaon to its junction with the Ganges, must be considered a convenient device of geographers, and not a term based on received usage. We have seen that at its junction with the Lohit, the Brahmaputra is called the Dihong.[1] East of this junction, the Lohit receives a tributary from the north, called the Dibong, and on the south another called the Dihing, and again one called the Disung. Much confusion has resulted in Asám geography from not remembering that all these names refer to different rivers.[2]

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[1] Any further discussion of the systems of the Asám valley would be out of place here; they are sufficiently described in the Asám Gazetteer, to which the reader in search of further information on this subject is referred.

Tibet.

We have already noticed the division of Tibet into the eastern, western, and central provinces. It is called Si-tsang by the Chinese, and is also known under the names Tu-pu and Mu-tu, or Upper and Lower Tibet. From the accounts of the eastern province in the writings of Klaproth, Huc, Blakeston, Cooper, Des Godins, and Gill, we may assume that the drainage to the east of the 96th meridian has a southerly direction, and that the general conditions resemble much those further west. Pengshan on the Yang-tse in western Sz-chuen is 1,500 feet above the level of the sea. At Ching-tu, some seventy miles due north of Pengshan, Cooper, in March, found the fields in the neighbourhood occupied by luxuriant crops of wheat, barley, sugarcane, and opium, the latter of which demands a climate similar to that of the plains below the Kumaon Himálaya. The same traveller crossed the Yalung and Kinsha branches of the Yang-tse between Chingtu and Bathang, and beyond Tatsien-lu entered Eastern Tibet, where yaks are used in the carrying trade and a more alpine climate is met with. Bathang on the west has much the same position with respect to the elevated highland to the north that Chingtu has on the east, but lies a degree of latitude more to the south than Chingtu; so that from the meridian of Bathang, the range dividing the Tibetan plateau from the plains of China seems to take a north-easterly direction. The feeders of the Yang-tse and other rivers find their way through this range by a series of gorges similar to that of the Dihong further west. Between the Yang-tse and the Dihong, we have two great rivers, the Lan-tsang identified with the Mekong or river of Kambodia, and the Lu-tse or upper course of the Salween. Father Des Godins informs us that the Mekong has its origin in about 33° to 34° north latitude in the mountains south of Koko-Nor, and the Lu-tse further west is known as the Ngen-kio in Tibet; but whether this name is to be regraded as one with the Nák-chu-kha of the Pandit explorer is left to future travellers to decide.

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[1] Klaproth suggested the Irawadi as the continuation of the Sanpo, and Colonel Godwin-Austen was the principal advocate for the Subansiri; Progs. R. G. S., August, 1876; but the researches of the Pandit employed by Lieutenant Harman perhaps show that the Dihong is the real representative of the Sanpo, and that the bend it takes beyond Chetang is quite sufficient to leave a large water-shed for the Subansiri. The most recent advocate of the Irawadi as the true continuation of the Sanpo is Mr. R. Gordon, in his elaborate "*Report on the Irrawaddy River.*" The first volume is illustrated with hydrographical hypsometrical and orographical maps of Tibet and the neighbouring countries together with a hyetographical map of India.

[2] See Peal's observations on Asám nomenclature in J.A.S., Ben.

Turning now to the upper portions of central and western Tibet, we find from the Pandit explorations that the drainage to the north of the northern water-parting of the upper portions of both the Indus and the Brahmaputra flows into a number of lakes. East of the 84th meridian, these lakes appear to be connected the one with the other, and eventually with the great river Nák-chu-kha, which has an easterly direction in the upper part of its course and finds a southern outlet in one of the great rivers to the east of the Dihong. From the Pangong lake on the west to the Lonkor Cho between the 83rd and 84th meridians on the east, the drainage is collected in a series of depressions without any outlet, each of which is the centre of a subordinate minor system of its own. We do not know of any considerable stream proceeding northwards or westwards from this tract. This lake-system is a characteristic feature of the orography of north-western Tibet. The waters of these lakes are generally brackish and the margins exhibit expanses of salt-marsh. Streams of fresh water are found, but in their course towards the lakes these rapidly become brackish, and in the end little influence the quality of the lake-water itself. According to the Pandit, the country to the north of Garge and Garchethol is a great uninhabited plain.[1] It was formerly customary to travel in a north-north-westerly direction from Thok Daurákpa[2] for some twenty days to the range overlooking the Gobi plain in which the commercial entrepôt Nári Thárn lay.[3] A two months' journey from Thok Daurákpa to the north-east brought the traveller to Ajan, also a commercial centre. This road lay throughout over an extensive plain ; no large mountains were seen and no streams were crossed. Drinking-water was obtained from a number of fresh-water lakes mostly dependent on the rainfall for their supply. From these reports we learn that northern Tibet is a plateau of great elevation without inhabitants and possessed of few streams.

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[1] Called Jung Pháyil Puyil, meaning literally "the desert country in which the father and son have wandered," from a tradition that two men had entered it and died there from want of water. G. T. S. Rep., 1873-75, p. 55.

[2] In about 85° 8' east longitude, and 32° 7' north latitude.

[3] Trotter suggests that Nári Thárn occupies a position at the foot of the northern boundary ridge of the Tibetan plateau, similar to that held by Polu and Sorghák, and that the stream passing Nári Thárn may be the same that passes by Charchand. Prejevalsky (p. 76) says that Charchen is situate about 200 miles to the south west of Charglik on a river of the same name. Hence it is a ten days' journey to the oasis of Nai (900 houses), and three days further to Kiria. The position and distance of Nai would suit the Pandit's description of Nári Thárn.

Lob-Nor basin.

As we approach the west, the boundary ranges that support the Tibetan plateau between them on the north and south gradually incline towards each other, so that westwards of the Pangong lake they are little more than fifty miles apart.[2] Here we find the water-parting of the Indus and Lob-Nor systems in the elevated Dipsang plain, which attains a height of 18,000 feet above the level of the sea near the Kárakoram pass (18,550 feet). From the Kárakoram pass on the north flows a feeder of the Yárkand river, and from the east, an affluent of the Kárakash river, both of which belong to the Lob-Nor system. On the south-east, only eleven miles from the pass, the Daulat-beguldi encamping ground is close to one of the feeders of the Nubra branch of the Shayok river that belongs to the Indus system. In one case the waters lose themselves in the Gobi desert, and in the other they reach the Indian Ocean at Karáchi. If the statements of Kostenko and Severtsof be accepted, we have here in the west an analogue of the arrangement that has been described as characteristic of all the river-systems along the southern face of the Himálaya between the Jumna and the Brahmaputra. The alpine basin of the Yamanyár lies between two great groups of peaks, some thirty miles apart. On the south-east of the Yamanyár is the Tágharma group, of which the Muztágh-Ata[3] peak attains an elevation of 25,350 feet above the level of the sea. On the north-west there is a similar group, of which the Tásh-balik peak reaches an elevation of 22,500 feet. The Yamanyár collects its waters in an elevated valley

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[1] On approaching Ajan, a bare rocky range is passed and the town is occupied by Sokpas, who procure their corn and flour from Kokod and Karka, a large monastery some ten or twelve days' journey beyond the borders of their country. Trotter suggests that Karka lies between Lob-Nor and Koko-Nor, and that Ajan is one with the Anj-si of Uspenski ; but both of these identifications require confirmation.

[2] From the Kárakoram to Shahídullah (11,780 feet) on the verge of the plains of Yárkand is a distance by road of 78 miles, and from the same to Changlung on the south is 83 miles, and to Leh on the Indus, 168 miles.

[3] 'Father of Ice-mountains.'

between these groups and the water-parting range on the west, which is known variously as the Tágharma plain or plain of the Kichik Kára-kul.[1] The groups themselves are in advance of the water-parting range and are connected with it by transverse ridges. That on the south connects the Muztágh-Ata group near the Kok Mainak pass with the water-parting range, west of the Neza-tásh pass, while that on the north has not yet been accurately defined. Spurs from the groups descend northwards towards the plains and effectually divide the waters of the Yamanyár from those of the Kashgár-darya on the west and from those of the Yárkand river on the east. It has generally been supposed[2] that these two groups of peaks belonged to a great meridional range; but Severtsof, who has had recently exceptional means for obtaining an accurate estimate of its character, distinctly states that "these two peaks were supposed to be connected by a continuous range, while the real fact is that each is respectively the highest point of separate small high mountain knots capped with eternal snow." We have, therefore, in the west also an apparent snowy chain of mountains as seen from the plains, but which on closer examination resolves itself into groups of snowy peaks in advance of the water-parting range from which they are divided by an elevated valley. This valley gives rise to a river that makes a way for itself between the boundary groups to the plains below, while the groups themselves are connected by transverse ridges with the line of water-parting. A ridge from Muztágh-Ata to Yangi Hissar separates the drainage of the northern slope from that of the Kinkol river on the east, and a second ridge follows at some distance the left bank of the Yamanyár which shortly after its issue from the mountains is absorbed in artificial branches or canals for irrigation purposes. The whole system is a remarkable illustration of Hodgson's formula for the river-systems of the eastern Himálaya.

Oxus basin.

The alpine affluents of the Yárkand river known as the Sarikol and Zarafshán rivers also illustrate the unitising principle observed elsewhere. They are separated from each other by the Kandár range, which descends in a north-easterly direction from the water-parting range to the south, and terminates where the Sarikol and Zarafshán unite their waters within the outer range of hills to the north. The Oxus system further gives an example of another of the characteristic features of the Himálayan river-systems. The water-parting follows the line of the Hindu Kush from the pass near Bámian to the Baroghil pass, and thence follows the Pámír range to the greater Kára-kul. The height of the water-parting on the Baroghil plain has been estimated by Captain Biddulph at about 12,000 feet. The Mullah states that in traversing it for a distance of five miles there was no appreciable rise or fall, and further it is said that from a point one-and-a-half miles short of the crest, the difference in height did not appear to be more than two hundred feet. The Sarhad head of the Panjah branch of the Oxus is not more than two miles distant from the Gez-kul or Oi-kul, the longest source of the Aksu branch of the same river known as the Murgháb. The principal source of the western head of the Panjah branch of the Oxus in Wood's Victoria lake is but twelve miles distant from the water-parting between it and another branch of the Aksu. So little is his water-parting marked by any defined physical feature that it was only after some difficulty that Trotter discovered it at a height of 420 feet above the level of lake Victoria. There is also reason to believe that the greater Kára-kul once gave off at one end a feeder to the Káshgár-darya of the Lob-Nor system, and at the other a feeder to the Oxus. We have already seen that it is but a little difference in perpendicular height that determines the drainage between the Satlaj and Karnáli and between the Nubra branch of the Shayok and the Kárakash, so that where rivers have their sources in these elevated areas it may be generally stated that a slight inequality in the surface, such as it is not possible to delineate on any ordinary map, is sufficient to determine the course of springs into channels that have a very remote debouche one from the other in the plains. The terms trough, channel, basin are in such cases often misleading. Nor are the bounding ranges in these elevated regions marked with such well-defined characters as are met with elsewhere. The great Pámír is divided from the Alichúr Pámír on the west by a range having an average elevation of only 3,000 feet above the level of the

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[1] Lesser Kára-kul or 'black lake.'

[2] The two groups form a part of Hayward's meridional Kizil-Art range, the existence of which was supported by Shaw and Trotter and denied by Fedchenko, who considered the phenomenon described by Hayward as merely representing the terminal butt ends of parallel ranges belonging to the Pámir plateau. Kostenko, however, maintained it to be a great mountain range. Views of the Muztágh-Ata peak and the Karikol valley are given by Gordon in his 'Roof of the World.'

Victoria lake, and from the little Pámír by a similar range averaging about 2,000 feet above the same level. The direction of the rivers depends, therefore, on the influence of much less relatively important masses of matter than are to be found at lower levels. The slight difference in level that determines the course of the head-streams of the Kárakash and Yárkand rivers on the Dipsang plains, is sufficient to divert the former from their normal direction and drive them directly against the Kuen-lun range, where, finding a fault in the wall, they work their way through towards the plains. The influence of the law of gravity and the mechanical and chemical changes wrought by water are the sufficient causes for every form of river channel that is met with, and it is to their ceaseless action that even the stupendous gorges of the Indus, the Satlaj, and the Brahmaputra, are due.

Plains of Hindustán.

Having concluded our review of the river-basins and their relations to each other, we shall now proceed to examine the different parts of the area under our consideration. The great plain of Hindustán which first claims our notice is a vast flat extending with an almost unbroken surface along the foot of the Himálayan slope from the upper Indus to the Bay of Bengal. Its direction is from north-west to south-east over a distance of nearly 1,500 miles, and having an area, including its western branch along the Indus and its eastern prolongation into Asam, of about 500,000 square miles. On the west it has its greatest development stretching along the Indus from the foot of the mountains to the sea, from north-east to south-east for a length of 750 miles. Its breadth from the Arvali hills to those west of the Indus is about 400 miles. The Arvali hills run in a north-easterly direction from the peninsula of Kathiawár until they lose themselves in the plain near Dehli. From this point they run in a south-easterly direction connecting with the Vindhyas, and in both cases constitute the abutments of the elevated plateau of Central India. They thus form two sides of a triangle with its apex towards the north, where it separates the Indus plain from that of the Ganges. The general slope of the Indus plain is south-west, with, as we have seen, a slight depression towards the south, until the influence of the northern slope of the Arvalis is felt, when it gradually rises again. Taking

Indus plain.

a line along the Indus,[1] we have Sehwan, 117 feet above the level of the sea; Shikárpur, 199 feet; Dehra Ghází Khán, 395 feet; Segra, on the eastern bank of the Indus, opposite Dehra Ismáil Khán, 606 feet; and Khairabad, opposite Kálábágh, 750 feet. Following the 32nd parallel from west to east, we have Sandi on the left bank of the Indus, 629 feet above the level of the sea; Lodri, on the left bank of the Chináb, 657 feet; and Rámdás, on the left bank of the Rávi, 796 feet: further east, we enter the hills. Following the 30th parallel we find Máre on the 71st meridian, with an elevation of 386 feet; Núr Sháh on the 73rd meridian, 482 feet; and Pakka Saráwa, on the 75th meridian, 698 feet. The perfect uniformity of the surface is broken in the north-west by the small table-land between the Indus and the Jhilam, of which the salt range[2] forms the abutment. These hills at the Sakesir station of the survey in the Jhilam district rise to a height of 4,994 feet above the level of the sea. They extend from Khairabad on the Indus to the Jhilam opposite Chilianwála, and thence those forming the eastern flank of the table-land as well as a subsidiary range to the east of the Jhilam turn abruptly north-east and connect with the outer ranges of the Himálaya near Bhimbar (1,200 feet). The table-land itself is seldom more than two or three hundred feet above the general level of the plain, and presents an undulating though tolerably even surface broken occasionally by ridges which attain a height of from two to three thousand feet.

Indian desert.

The Indus plain along the foot of the hills is sufficiently watered, but to the east and south at any distance from the rivers cultivation on an extended scale is only possible when the scanty rainfall can be aided by artificial irrigation. The latter tract known as the great Indian desert stretches through Bhatiána, Bikanír, and Baháwalpur into Sind. Tradition tells us that in former time it was a fertile and populous country studded with numerous cities and towns and inhabited by prosperous and civilised tribes. A recent writer[3] states that "there is nothing in history to show that the rivers (of this tract) ever contained much more water than they do now. Some diminution in their volume may have taken place during the lapse of ages, from changes in the lower Himálayan range, as well as from the destruction of forests and increase of irrigation. There is no doubt also a tendency to the obliteration of the lower part of their course; partly by the drift of sand and dust from the desert; and partly by the deposit of the silt brought down by the streams themselves, owing to the absence of the great river by which it would have been carried off to the sea." Between the Sarasvati and the Satlaj are a series of broad channels, most of them a mile in width, of which those to the west appear to terminate in the valley of the Satlaj, while those to the east, which are also the more ancient, lead to the channel of the lost river Hakra or Sotra.[1] The Kaggar now runs in an old bed of the Satlaj and was formerly an affluent of that river. The change may have taken place owing to some great cataclysm[2] which formed a new bed for the river and left the old one for its tributaries on the east, and there is much to be said in favour of the identification of the Sotra channel with this old bed. At the present day the water-level in wells in this tract is excessively low, being often so deep as three hundred feet from the surface. As the water when procured is often brackish, it is a matter of wonder that people are found to inhabit this country which long ago received the name of Marusthali, 'the region of death.'

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[1] All these heights are taken from the records of the Great Trigonometrical Survey. [2] Fleming on the salt range, J. As. Soc., Ben., XXII., 229. [3] Cal. Rev., July. 1874, p. 3.

Gangetic plain.

The Gangetic plain extends from the debouche of the Jumna from the hills to the head of the delta of the Ganges, and lies between the great bend of the Himálaya and the north-eastern slope of the table-land of Central India, which here has a general elevation of about one thousand feet above the plain. The breadth of the plain varies from about two hundred miles at Agra to about one hundred miles at Rájmahál. The direction is to the south-east, but to the east of the Ganges the courses of the rivers exhibit more southing. A general idea of the fall in height along the course of the Ganges may be obtained from the following figures: Sahåranpur, 903 feet above the level of the sea; Meerut, 735 feet; Aligarh, 610 feet; Agra, 516 feet; Cawnpore, 517 feet; Allahabad, 315 feet; Benares, 255 feet; Patna, 174 feet; Bhágalpur, 159 feet; and Bardwán, 97 feet.[3] Cross sections show little difference in height at any point. Bhatpura, below Mohan, at the entrance to the principal pass into the Dehra Dún, is 954 feet above the level of the sea. Following eastwards the line along the foot of the hills, we have Hardwár, 1,016 ; Najíbabad 860 ; Barhapura, 910 ; Káshipur, 750 ; Bilahri, 760 ; Sigauli in Gorakhpur, 300 ; Madanpur in Tirhut, 230 ; and Amua, 248 feet.[1] Noting these figures on any good map and following the course of the rivers, a sufficiently correct idea of the general slope of the Gangetic plain will be obtained. At the termination of the hills near Rájmahál, the plain once more expands largely to the south and again presents an uninterrupted surface from the mountains to the sea. The length of this section is about 350 miles, and its breadth from Rájmahál to the Brahmaputra about 150 miles, but increasing to about 300 miles along the coast at the head of the Bay of Bengal. The height varies from 100 feet, the level of the river Mahánadi at Málda,[2] to 75 feet at Jelinghi, the head of the Hugli branch of the Ganges,[3] and 31 feet at Chinsurah. The Howrah station bench-mark is but 18·2 feet above the level of the sea.[4] These portions of the great plain, often though not very appropriately called the valley of the Ganges, are intersected by the countless tributaries of that river and are under the full influence of the periodical rains. They therefore, as might be expected, comprise the richest, the most populous, and the most civilised districts of India, and in these respects form a striking contrast to the western parts along the Indus which are doomed to perpetual sterility, not from any natural deficiency in the quality of the soil, but only from the great aridity of the climate. This barrenness is no doubt, in a great measure, due to the relative position of the Indus plain to the higher ground around it and to the prevailing winds ; matters which, at first sight, appear to be of little importance, but which are the efficient causes of the extremely dry climate that it possesses. Fluviatile action in erosion and deposition, productive of the alluvion and diluvium, terms so well known in the settlement records of these provinces, has clearly directed the course of the rivers in the great Gangetic plain. Mr. Fergusson, in an article quoted by the authors[5] of the 'Manual of the Geology of India,' shows that the rivers of the Ganges delta oscillate in curves, the extent of which is directly proportional to the quantity of water flowing down their channels. Thus, the oscillations of the Ganges between Mungir and Rájmahál average 9½ miles, and between Allahabad and Chunár, only 3·7 miles in length. Further, when a great river runs through a low country, its course is considerably stayed by the sluggish expanses of stationary water generally termed *jhíls* in Bengal, and it is thus compelled to deposit its silt along its banks. Hence arises the phenomenon of a river passing through a country between banks that are higher than the adjacent alluvial flats, and the gradual increase of the banks until the stream makes its way through them to some lower level. Mr. Fergusson estimates that when the slope of a river bed falls to less than six inches in a mile, a denuding river will be converted into a depositing river, and as the deposit commences at the bottom of the slope, the change proceeds up-stream. Moreover, since the Ganges receives its more considerable affluents from the north, the left bank gradually increases and drives the main stream more and more towards the table-land of Central India, and makes the point of confluence of its affluents continually move upwards. This tendency is well marked in the Jumna in the Mainpuri district, where the old silted-up bed is locally known as the *bhagna*.[1] In the Tarái below Kumaon the same law prevails, and streams that in the upper portion of their course are denuding rivers in the lower portion where the check in slope occurs deposit their silt, form jhíls, and continually change their courses like the rivers of the Gangetic delta.

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[1] Said to have dried up in the thirteenth century.

[2] Like that of 1762, when, according to General Cunningham, the river was dammed up by a landslip in the hills and rose some four hundred feet before the barrier gave way. A similar cataclysm occurred on the Indus.

[3] From G. T. S. tables.

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[1] First five from Webb and Sigauli from Kirkpatrick. [2] Hooker [3] Prinsep. [4] G. T. S., 52 : in sc. VIII.. 1866. [5] Pp. 406. 412.

Asám valley.

The Asám valley forms a narrow prolongation of the eastern extremity of the plain, partaking more, however, of the nature of a simple river valley liable to annual floods. It has a length of about 300 miles with a breadth of thirty to forty miles, widening at its junction with the

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[1] Gaz. IV., 478. The old bed in Saháranpur is called the Budhi Jumna.—*Ibid*, II., 140. Remains have been found in the Jumna alluvion near Allahabad.—J. A. S., Ben., III., 302, 529 : IV., 262, &c. Wilford also notices the discovery of bones of men and animals in the Ganges alluvion near Benares about a furlong from its present bed at ninety-five feet from the surface and thirty feet below the level of the present bed. He says the human bones were entire, but those of quadrupeds were broken and bore evident marks of their having been cut with a sharp instrument He found no marine deposits at over 105 feet when the water-bearing strata was reached.—As. Res., VIII., 294. He has also noticed the fact that the point of junction of the Kosi with the Ganges had moved up from Nawábganj opposite Rájmahál some twenty-five miles.

Gangetic delta. It is shut in on all sides, except the west, by mountains. The characteristic of a sudden and total change along a definite line at the foot of the mountains from a broken hilly surface to an absolute flat, which holds good throughout the other parts of the plain, here no longer prevails. We frequently see small isolated hills standing out like islands from the general level surface, a phenomenon observable on a smaller scale where the Vindhyan range mingles with the plain. From Sadiya, which is 440 feet above the level of the sea, the fall is gentle to Gauhati, which is placed at 163 feet, and Goálpára, which is 150 feet.[1] Taking a line along the foot of the hills, we have Titaliya, 330 feet; Rájhát at the foot of the hills near Buxa, 220 feet; and the station at the foot of the hills below Diwángiri, 670 feet: figures[2] which show a more sudden descent than those at similar positions under the western Himálaya.

Bhábar.

We shall now return to the plain between the Jumna and the Sárda, and more particularly to that part which lies immediately below the foot of the Kumaon hills. We find there a narrow belt of country usually covered with forest and remarkable for the entire absence of water, a phenomenon eminently characteristic of this tract. The great rivers preserve their course with some diminution in their volume, but all the minor streams that have their origin in the lower hills on entering this belt soon lose themselves in the shingly deposit that constitutes the substratum. In time of flood, however, they often preserve a visible stream throughout their course, but this appearance lasts only so long as the cause exists. This belt of waterless forest land is called the Bhábar or *ukhar bhúmi* (waterless forest) under Kumaon, and has a breadth of from five to fifteen miles. Though no stream or spring exists, the Bhábar is clothed with a magnificent forest finding its nourishment in the few feet of alluvial matter that rests on the boulder and shingle deposit below.[3] To the south of the Bhábar, the character of the country changes into a swamp devoid of trees and intersected by sluggish streams that rise from unhealthy morasses. This tract is included with the Bhábar between the Ganges and the Phíka under the general term *ban* or jungle. East of the Phíka under Kumaon, where it apparently attains its maximum breadth, it is known as the Tarái, and under Nepál as the Taryáni, with some specific addition as Morang, &c. It lies between the forest belt and the cultivated plains, with an average breadth of about ten miles under Kumaon, though varying much in different parts. Thus we have between the plains proper under Kumaon and the foot of the hills two distinct belts of country, each about ten to fifteen miles broad, known as the Tarái and the Bhábar. The Tarái is characterised by the presence of reeds and grasses showing the marshy nature of the ground. The streams carry off only a portion of the superfluous moisture and sluggishly run in tortuous channels, doubling back constantly in their course. The soil consists of moist alluvial matter without a sign of rock either in fragments or in site. In the Bhábar, on the other hand, no water rises from the ground. Throughout its whole extent not a single spring nor any water can be seen, except occasionally where one of the larger rivers takes its course. In the rainy season alone torrents cut into the ground, and the channels thus formed exhibit characteristic sections of this remarkable tract. We then find that there is but a thin covering of alluvial soil on a vast dry bed of boulders and of shingle, through which all rain that falls sinks rapidly, and which absorbs in the same way all the minor streams of the outer ranges. Instead of reeds and grasses, we have here all the magnificence usually attributed to oriental forest scenery. Gigantic *haldús (Adina cordifolia)* and *khairs (Acacia catechu)* rear their heads above a tangled undergrowth of creepers and thorn-bushes which present a barrier to progress that an elephant alone can surmount. Towards the hills we find the *sál*[1] *(Shorea robusta)*, and in Kota great groves of mangoes, while patches of cultivation appear wherever irrigation is practicable. For this

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[1] These figures are from the Great Trigonometrical Survey records, which make Dibrugarh, 348 feet above the level of the sea; Sibságar, 319 feet; and Baramak, near Tezpur, 456 feet. [2] First from Hooker, two last from Pemberton.
[3] These descriptions are chiefly based on Herbert's report; and on an article entitled 'The Himálaya in Kumaon and Garhwál' by Mr. (now Sir John) Strachey, Cal. Rev. No. 85. Stewart notes that he can find no definite statement as to the breadth of the tract known as Bhábar and Tarái to the east of Sikkim, but Hooker mentions expressly that there it ranges from 8 to 12 miles in width; Kirkpatrick and Hoffmeister coincide in making its breadth opposite Nepál about 10 or 12 miles, and between the Sárda and Rámganga it ranges from 20 to 30 miles, falling to 6 or 7 miles abreast of Garhwál and disappearing to the west of the Jumna.

Tarái.

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[1] The *sál* is the characteristic tree of the upper Bhábar wherever it is found. Hodgson notes that constant observation has enabled the people of the Tarái to distinguish the principal belts of the Bhábar from the trees that grow in each. The highest is the *sál* level, the next is the *khair* level, and the lowest is the *sisu* (*Dalbergia sisu*) level.

purpose, the streams of the lower hills are turned into artificial channels before they reach the shingle deposit, and even the lakes in the lower hills are dammed up to retain a sufficient supply of water for the Bhábar. West of the Kosi, however, there is little cultivation or irrigation, and the Bhábar there almost remains untouched by the plough. The actual slope of the ground between the Tarái and the foot of the hills is considerable, though not apparent to the traveller, except when he observes the rapidity of the current in the irrigation channels that line the road by which the Bhábar is crossed.

Siwáliks.

Before entering into more detail regarding the Bhábar and Tarái, there is yet a third feature characteristic of the tract below the Himálaya that must be noticed here as intimately connected with the other two, and this is the line of hills called the Siwálik[1] or sub-Himálayan. These will be well known to palæontologists in connection with the rich collection of fossil mammalian bones discovered in them by Dr. Falconer and Colonel Cautley. As a rule, they appear to rise abruptly and without any intermediate undulating slope from the apparently lével surface of the flat country below to heights varying from a few hundred to three or four thousand feet. They are composed of sandstones and conglomerates, and the dip of the strata is usually towards the general mass of the mountains at a low angle. The form of disturbance of the strata is very regular, producing broad normal anticlinal flexures, the axis-plane sloping towards the mountains. Towards the plains the slope has been weathered out, so that plainswards the Siwáliks exhibit a steep face from which rise the highest summits of the range, while a long gentle declivity slopes inwards and forms a longitudinal shallow valley by meeting the foot of the next line of hills. The latter, as a rule, run on a line parallel to the Siwáliks, but at a distance of from five to ten miles from them.

Dúns.

The bottom of this longitudinal depression is, as may be supposed, by no means continuous. In some places it is cut through by the passage of the streams that drain the interior of the mountains ; in others, it is quite obliterated by the near approach to each other of the two ranges that flank it, and which usually form distinct lines. This is, moreover, a structural feature and not due simply to denudation. In the country between the Satlaj and the Káli, these valleys are called Dúns and under Nepál, according to Hodgson, they are called Máris. They have been confounded by some writers[1] with the Tarái, which, as we have seen, is quite distinct. The lower part of the Dúns generally appears to be covered with a deposit of boulders and gravel that slopes somewhat steeply from the Himálaya towards the Siwáliks, so that the whole bottom of the valley is considerably raised above the level of the plain without. In consequence of this elevation, the outer hills when viewed from the interior of the valley, as from Masúri, present a very insignificant outline. The drainage of these valleys usually collects along their longitudinal axis and either falls into some of the larger streams that cross them, or less frequently finds an independent exit for itself into the plains by a sudden bend to the south through a break in the outer range. Owing to the considerable elevation of the Dúns above the plains down to the level of which the drainage finds its way in a very short distance, the unconsolidated strata that form the floor of these valleys are constantly cut through to a great depth by water-courses. Consequently, the surface, though often presenting an apparent flat for several miles together, is frequently broken up into steps which, on the whole, are tolerably level, but at different heights, the one above the other. This phenomenon is not uncommon, and is constantly observed along rivers that are eroding their banks. To the same causes also are to be attributed the practical impossibility of procuring water by means of wells in the Dúns, a difficulty which mainly arises from the thorough dessication of the gravelly soil by the deep drainage.

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[1] Sivawála, belonging to Siva ; for use of the term 'Siwáliks' by Musalmán historians, see 'History' *postea*.

Extent of the Bhábar.

We have not sufficient information to state distinctly how far the Bhábar extends both east and west along the foot of the Himálaya, but the following indications would lead us to suppose that this phenomenon is inherent in the relations of such a mass as the Himálaya with the subjacent plains. Under Nepál it is called the Jhári or Bhávar, and, according to Hodgson,[2] extends from the Káli to the Mechi on the east with the same general characteristics as under Kumaon.

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[1] Somerville's Physical Geography corrected in 7th edition, 1878.

[2] Physical Geography of the Himálaya.—J. A. S., Ben., XVIII., 778.

Eastward of the Tista, according to the same writer, the Bhábar and Tarái do not exhibit the same parallelism to the line of the Himálaya, but "show themselves plainwards, like an irregular series of salient and re-salient angles resting on the mountains. Or like small insulated plateaus or high undulated plains, surrounded in both the latter cases by low swampy land analogous to the Tarái." An example of the former is found in the plateau called the Parbat Joár on the confines of Asám and Rangpur, which is considerably elevated, quite insulated, remote from the mountains and covered with *sál*, the characteristic tree of the upper Bhábar. Again, we have undulating plains, such as those that occur around Dinajpur and to the north-west and north-east of Siligori, all of which may be identified with the Bhábar. In all these cases where the detritus bed thins out, a moist tract is met with, though in no case so marked as to the westward. Herbert[1] affirms the general applicability of his remarks regarding the submontane tract below Kumaon to the entire country between the Ganges and the Satlaj and Parish[2] to the tract further west between the Satlaj and the Biás. There is no well-defined line dividing the area of swamp from the Bhábar proper between the Sárda and the Rámganga. To the east in the Tallades Bhábar, where the streams seek the Sárda directly, there is less Bhábar, and the swamps that exist are not so extensive, but at the same time are more formidable, being often surrounded by tangled masses of canebrake. The Dhyánirau Bhábar also is comparatively narrow, and it is not until we come to the Chhakháta Bhábar that we get a breadth of eight to twelve miles that lasts until the Phíka river is reached. The Tarái exist all along the tract to the south of, and parallel to, the Bhábar from the Sárda to the Phíka. But west of the Phíka it loses its characteristics and can only be traced in the closeness to the surface of the water-level in wells. Westward of the Phíka, the Bhábar or waterless tract also narrows and the *sál* forest does not descend more than six miles from the foot of the hills, and a few miles further west it has not a breadth of two miles. The Bhábar, however, exists, and is broader than the present *sál* forest, of which much has been cut down of late years. Its presence is shown by the absence of wells, and similarly the Tarái appears in a line of wells with water at from three to six feet from the surface, running parallel to and bordering on the Bhábar. This limitation of both the Bhábar and Tarái is conterminous with the commencement of the Pátli Dún, which has detained the greater part of the detritus that is elsewhere spread out below over the plains. From the Phíka eastwards to the Sárda, where these tracts attain their maximum importance, there are no Dúns, properly speaking; for the Kota Dún presents no great barrier to the south, and further east the Siwáliks are so blended with the outer range that a geologist alone can trace their sequence. In this fact, we have an illustration of that portion of Hodgson's theory that gives a narrow extent to the Bhábar below the Dúns and a broader range where there is no Dún to intercept the débris from the hills. The facts that we know regarding the Bhábar to the north of the Saháranpur district[1] further confirm this deduction.

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[1] Report of the Mineralogical Survey of the Himálaya Mountains, *Ibid*, extra No., Vol. XI. [2] Kohistán of the Jullundhur Doab, *Ibid*, XVII., p. 281 : XVIII., p. 360.

The Bhábar in Turkistan.

In Eastern Turkistan we find a similar phenomenon. Trotter tells us that the Sagon river, which has its source at the eastern foot of the Terek pass, after it reaches the plains north of Kalti Ailak wastes away and leaks through crevices in the stony ground. The hákim of the latter place assured him that wells had been often sunk but proved of no use. Trotter writes :—"This diminution in the size of rivers as they descend is one of the chief characteristics of the country, and occurs in all minor streams that have come under my notice. Of course much of this is due to irrigation, which necessarily carries off large quantities of water, but the stony soil has also much to answer for; on the other hand, the frequent appearance of large springs giving considerable supplies of water and often issuing from the open plains at long distances from the mountains may account in a great measure, if not fully, for the water thus lost in its early infancy." Here we have the existence of a Bhábar and Tarái vouched for by competent authority in the Yárkand and Kashgár country. The same phenomenon, but on a larger scale, was found by Prejevalsky to characterise the tract between Korla and Lob-Nor. A belt of country about three to four miles wide, consisting of an undulating plain covered with a pebbly or gravelly soil and totally devoid of vegetation, runs parallel to and at the foot of the Kurugh-tágh, a low waterless and barren range. Beyond this stony margin, which appears to define the shore-line of an ancient sea, lies the great desert of drift sand amid which salt marshes exist wherever the moisture comes to the surface. The same pebbly plain was found under the northern slope of the Altyn-tágh, the north-easterly continuation of the Kuen-lun mountains between the 90th and 92nd meridians, and north of and below the stony margin the usual salt marshes occurred. The latter are also found at the foot of the north-eastern portion of the Tibetan table-land in Tsaidam. It would, therefore, appear that tracts analogous to the Bhábar and Tarái of Kumaon surround the entire Himálaya-Tibetan mass, and that they vary in character according to local influences.

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[1] Gazetteer, II., 140.

Cause of the deposit: Hodgson's oceanic theory.

Hodgson attributes the distinctive character of the Bhábar, as a whole, "to the vast mass of diluvial detritus which was shot from the mountains upon the plains, like gravel from a cart, at some great geological epoch, and which has been, since its deposit, variously and often abraded both in degree and direction by oceanic and, in a far less degree, by ordinary floods." Another writer considers that this theory of Hodgson's appears to be a reasonable explanation of the existence of these great beds of shingle, sand, and boulder all along the foot of the mountains. It is argued that no rivers can have laid out such a vast deposit, and we can only conclude that we see here the limits of an ancient ocean that once washed the base of the Himálaya. The boulders and shingle are spread out only for a distance of ten or fifteen miles from the mountains from which they are derived, while the finer particles of sand and clay are carried much further. Great variations in the depth and breadth of the deposit occur, due, in a great measure, to local causes. One which apparently has had a great influence is the existence or otherwise of the Siwálik range. Where there was no sandstone range to intervene between the mountains and the plains and collect the detritus within their contained Dúns, the deposit is broader and not so thick. Where there was such a barrier, it has been carried less southwards and exists in great accumulations between the barrier and the mountains. Again, where no range existed but only spurs sent forth, like bent arms, upon the plains from the mountains, Hodgson observes that the embayed detritus is simply deeply piled and lofty within such spurs, and thinly and unequally spread without them, by reason of the action of the spurs on the current. He notices, as an example of this form, the débris embayed by a spur on the road to Darjiling by Pankabári, where it is accumulated to several hundred feet, and where, moreover, there is outside the spur a succession of terraces, apparently due to oceanic forces.[1] Further, "where, as from Gauhati to Sadiya, there was not room upon the plains for the free spread and deposit of the detritus owing to large and rapid rivers and to other chains both proximate and parallel to the Himálaya, the phenomena, created elsewhere by the more or less unrestricted spread of the Himálayan detritus over the plains, would necessarily be faintly, if at all, traceable. Lastly, if at the time of the descent of the débris, there existed a great dip in the Gangetic plain from north-west to south-east, the lithologic character, as well as the distribution of the débris, would be materially affected thereby, for the subsiding oceanic current would have a set from the former to the latter quarter and would continue to lash the gravel into sand and here to deposit both in a series of terraces, there perhaps utterly to displace both in the latter quarter long after the former had emerged from the waves."

Fluviatile theory.

The oceanic theory of Hodgson is not accepted by the majority of professed geologists. Mr. W. Blandford writes:[2]—"There is absolutely no proof of any sort or kind that the whole Indo-Gangetic plain has at any time been a marine area; but there is equally no proof that it has not. It has been shown that in eocene times the sea occupied the Indus valley as far as the foot of the Himálaya, and extended along what is now the base of the mountains, as far east as Kumaon; and also that marine conditions prevailed to the north-west throughout a great part of the tract now occupied by the Asám range; but it was also pointed out that, in the area between Kumaon and the Gáro hills, no trace of marine formations had been found. Yet it is difficult to understand, if the Gangetic plain was a sea-basin, why no marine beds occur. It is true that the northern border of the plain, throughout the most important part of the intervening space in Nepál, is, unfortunately, inaccessible to Europeans; but still, if the Gangetic plain in any way corresponds to an eocene sea, as the Indus plain doubtless does, why are no traces of marine beds found to the south of the valley on the margin of the peninsular area, as they are in the desert to the east of the Indus? In the Brahmaputra plain, also, no marine deposits of tertiary age are found; in the plain itself only fluviatile deposits have been detected and the marine, eocene, and miocene beds are confined to the southern slope of the range forming the southern watershed of the valley." Mr. Blandford considers the post-tertiary formation of these provinces to be clearly river deposits. The latter tertiary formations belonging to the Siwálik series contain reptilia and mollusca, but not a single marine shell. "It is impossible to tell what beds may be concealed below the Indo-Gangetic alluvium, and marine strata may exist to an enormous extent without appearing at the surface; it is also unquestionable that the amount of information hitherto derived from borings is very small indeed, but so far as that information extends, and so far as the lower strata of the alluvial plain have been exposed in the beds of rivers, not a single occurrence of a marine shell has ever been observed, nor is there such a change in the deposits as would render it probable that the underlying stratra are marine * * . The only evidence known in favour of marine conditions having prevailed during the deposition of any portion of the Gangetic alluvium is the occurrence of brine springs at considerable depths in a few localities. These springs, however, are not numerous, and, without additional evidence, it is impossible to look upon them as proofs of marine deposits. At the same time it is by no means impossible that the sea occupied portions of Sind and Bengal long after the plains of Upper India were dry land." On the whole, Mr. Blandford thinks that the oceanic theory wants further support; that the fluviatile theory is the only one that fits in with the present state of our knowledge, and that the depression of the Gangetic plain is of contemporaneous origin with the disturbance and contortion of the Himálayan ranges, and that the physical features of the two areas are closely connected. No important borings have ever been made in these provinces, and nothing has ever been discovered, so far as we are aware, to show that the older theory is the correct one. The newer theory is further supported by the discovery of the buried town of Behat in the Sahåranpur district, some seventeen feet below the present level of the country and containing coins of the commencement of the Christian era, thus showing what can be effected by fluvial action in eighteen centuries.

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[1] The oldest advocate of the oceanic theory is Wilford (in As. Res., VIII., 292), who thus accounts for several statements made by the Pauránik geographers, and particulary the story of Sagara. He, however, acknowledges that the existing soil of the Gangetic plain, so far as is known, was due to fluviatile action.

[2] Manual of Geology of India, p. lx., 393.

Tarái.

We have already seen that the distinctive features of the Tarái are not found west of the Phíka river, if we except a small tract on the left bank of the Rámganga, the condition of which, however, is probably due to defective drainage in that particular part, and might occur in any other place. The existence, therefore, of the Tarái as a distinctive feature must be due to local causes capable of explanation, but the imperfect nature of our knowledge will only allow us to guess at them. Herbert[1] described the Tarái as "defined in its southern boundary by a rise or step which runs parallel to the common boundary of mountain and plain land." He observes the height is variable, occasionally as much as thirty feet and sometimes sudden and steep. Modern research can discover no well-defined boundary beyond the chain of springs which sometimes approach within a couple of miles of the foot of the hills and sometimes are separated from them by a belt fifteen miles wide. In no case is there any such rise or step as described. Hodgson[2] also accepted the existence of a longitudinal trough running parallel to the Himálaya as a characteristic of the Tarái, which he held to be a natural depression in the plain, and thus accounted for its peculiarities. This theory, however, is opposed to the results obtained by levelling operations and appears to be based on an entirely erroneous idea, the fact being that the drainage of the higher country, beyond which has been lost in the absorbent strata of the Bhábar, here breaks out again in a line of copious springs which collect into swamps in the Tarái. This feature has also somewhat plausibly been accounted for[3] by the existence of an impervious stratum below the absorbent boulder detritus, and as the latter gradually thins out the finer and less permeable silt underlying it approaches nearer, and eventually reaches the surface, bringing with it the water that has been absorbed by the shingle talus and has been retained by the impervious silt.

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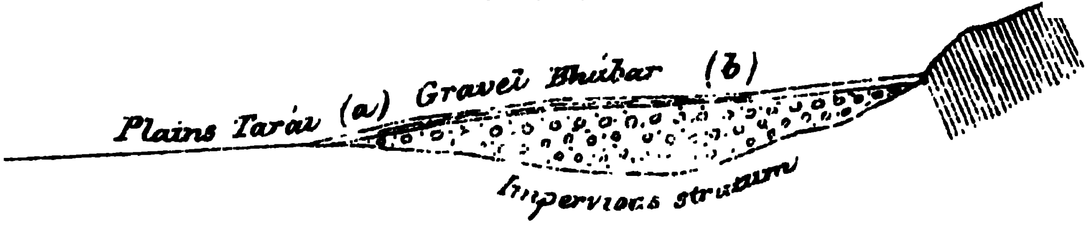
[1] *l. c.*, art. 73. [2] *l. c.*, p. 788. [3] Batten in Kumaun Reports, p. 184.

FIG. 1.

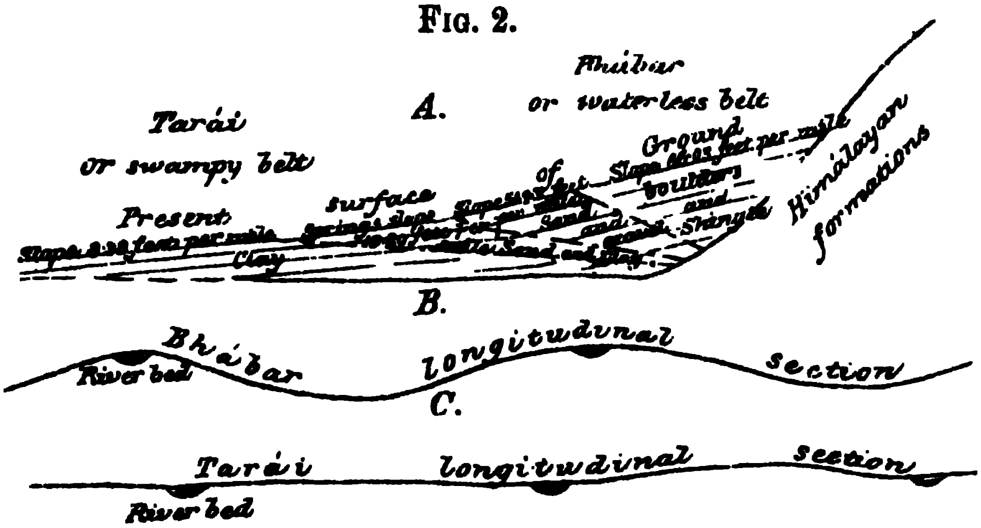


(a) Point of re-appearance of water. | (b) Point of disappearance of water.

Although this explanation seems reasonable so far as it goes, it must be remembered that the swampy Tarái extends only from the Phíka to the Tísta, and we must, therefore, look for some peculiarity in this part of the plain which does not exist elsewhere, by which we may account for the existence of swamps exclusively in this particular locality.

In a recent note, Mr. Lawder gives the following section of the Bhábar and Tarái :—

FIG. 2.



His experience of this tract has led him to consider that, whatever may be the nature of the underlying formation, the surface beds are solely due to fluvial action. The mountain torrents along the foot of the Kumaon hills bring down every year a vast amount of débris which is spread out over the surface now on one side of their previous course and again on the other. This irregular deposition itself compels the torrents to change their beds from place to place until, as now obtains, the points where they debouche from the hills are marked by more or less irregular, great, fan-shaped boulder and gravel deposits. The clayey or semi-soluble particles are necessarily carried farthest and are readily deposited not only where there is a check in the slope, but where the current is impeded by the tortuous nature of the channel which itself naturally assumes that form under these conditions. Here, during the rains, the streams saturated with clayey silt, overflow their banks, form new channels, fill up old ones, and create the Tarái. Above this deposit of clay we find one of clay combined with sand, in which, however, the latter predominates. From this bed issues the line of Tarái springs that flow uninterruptedly throughout the year, and its margin marks the northern boundary of the Tarái. Above we meet beds of sand and gravel or gravel and boulders as we approach nearer to the hills. A longitudinal section taken at the top of the Bhábar (Fig. 2 B.) will show that the hill torrents in the upper portions of their course run along a ridge formed by the débris transported by themselves, whilst a similar section of the Tarái (Fig. 2 C.) would show that, as a rule, the river channels are found in depressions below the general level of the country. The geological section (Fig. 2 A.) shows the gradients of the present ground surface on the road between Bareilly and Ránibágh, and from them it will appear that in the boulder region deposition takes place at a slope of sixty-six feet to the mile, whilst the clay is not deposited until the descent falls to about eight feet in the mile. It may fairly be assumed that these are the usual angles of deposition of the materials, and that they have obtained since the degradation of the lower hills and the resulting deposition below them commenced. If so, a series of proportionate curved lines running almost parallel to the present ground surface may be taken to represent the ground surface of succeeding periods, and such portions of these lines as may be similarly inclined with the present Tarái portion (*i.e.*, at the same angle with the horizon) will evidently represent the Tarái or clay deposit as it then existed. A line intersecting all these beds at the several points of junction of the 'clay' with the 'sand and clay' will represent the present impermeable bottom of the Bhábar basin and account for the line of springs upon the surface where the stratum of sand and clay crops out. The upper boulder and gravel beds permit of the filtration of water freely through them to the clay, at the same time acting as a capillary reservoir to keep up the dry weather supply to the springs below.

We have further evidence in support of this theory in the fact that the Tarái proper does not extend westwards of the Phíka river.

Between the Phíka and the Sárda there are no Dúns, for the Kota Dún has its southern boundary broken through by rivers, and along the entire tract numerous torrents find their way directly to the flat country below. The proximity of these torrents to each other causes the accumulation of débris to exhibit a continuous appearance which seems to have suggested the theory of a marine origin. To the west of the Phíka river, the drainage of the lower hills is carried off mainly by streams which collect the drainage within the Sub-Himálayan range and seek the plains in one well-defined channel. The Rámganga is the great arterial drainage channel for lower Garhwál, and between it and the Ganges, the only considerable stream is the Khoh, which has a small strip of Bhábar below it. In eastern Kumaon the Ladhiya serves a similar purpose, and where in its course towards the Káli it approaches the plains and does not allow of any considerable stream from the southern face of the outer range, both Bhábar and Tarái are narrow, and as this influence of the Ladhiya on the east and the Rámganga on the west decreases the Bhábar and Tarái increase and eventually attain their maximum breadth where that influence is least felt. Where rivers discharge large volumes of water like the Ganges and the Sárda, and in a lesser degree the Rámganga and Kosi, the velocity at their debouches from the mountains is much less than that of the minor torrents, owing to their having cut back and more deeply their channels within the hills, so that only the lighter particles of eroded matter are carried onwards, whilst the boulders are left behind at their natural point of deposition. Hence, near these larger rivers it curiously happens that the width of the Bhábar and Tarái contracts in a certain ratio and in the case of the Ganges disappears.

This explanation is supported by the results obtained during the contour survey of the Tarái.[1] The second diagram[2] (Fig. 3) shows a portion of the country between the Dhora river and the Bhúta stream, taken from the survey maps, and will illustrate the intricate nature of the levelling operations, and show why in some places the streams double back on their original direction and exhibit the tortuous courses so characteristic of this tract :—

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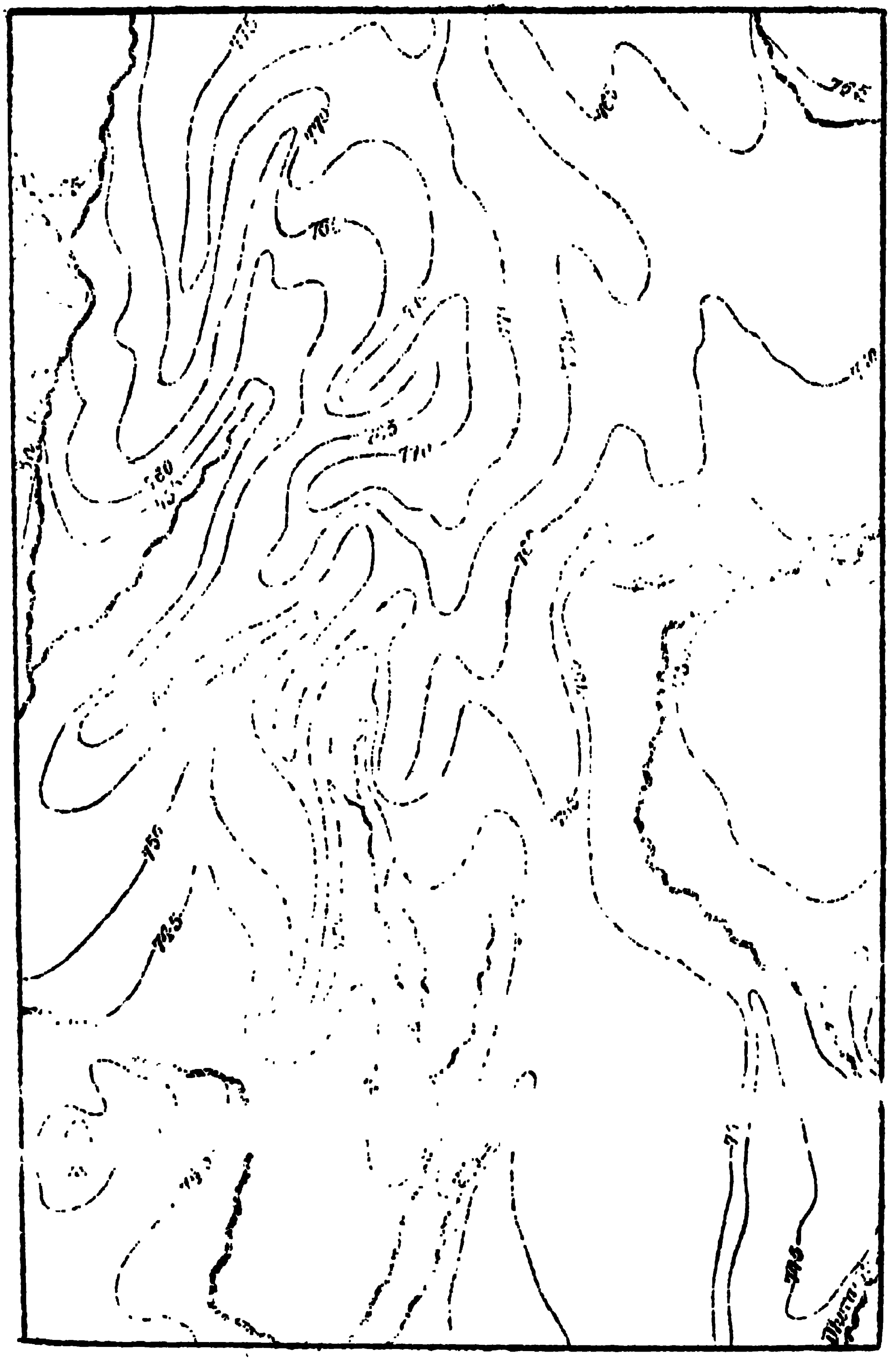
[1] See Proceedings, N.-W. P., P. W. Department, May 31, 1864; July, 1869; February, 1872.

[2] From the Rohilkhand remodelled canals' contour map of a portion of the Tarái surveyed in 1865-67 by Captains Thomason and F. Brown and Lieutenant Bisset. An examination of the records of this survey shows that what is stated regarding the portion noticed here is true also of the entire tract between the Phíka and the Sárda.

FIG. 3.



It will also be observed that there is a sudden check in the slope where the Tarái commences; to the north in the Bhábar the slope is from sixty to a hundred feet in the mile, and in the Tarái it falls to about ten feet. These are the adequate causes of the existence of swamps, and though the neglect of artificial obstructions made for the purpose of utilising the water for irrigation may doubtless aggravate the natural defects of drainage, it would probably produce no effect whatever were it not for the peculiar physical conditions that exist here. To the west between the Indus and the Ganges, the great arterial drainage lines collect within the hills and run off directly from them, the general fall of the surface receiving no such check as is found under Kumaon. The same is true of the country to the east along the head of the Bay of Bengal, and in the narrow valley of Asám, the Brahmaputra runs in a deep bed at right angles to the natural course of the streams from the hills, and thus forms a perfect system of cross-drainage that does not allow of the formation of swamps.

Siwáliks.

The Siwáliks appear to have a more or less definite existence along the whole of the Himálaya from the Indus to the Brahmaputra, presenting modifications of the same general features along the entire line. To the eastward of the Tísta they are wanting locally, a fact which it has been suggested is due to denudation as in the case of the partially obliterated barrier to the south of the Kota Dún. As the Siwáliks will be noticed hereafter in the chapter on the geology of Kumaon, we need not describe them here.[1] Between the Jumna and the Sárda they are found as the southern boundaries of valleys as far eastwards as the Nihál river, and thence onwards they almost coalesce with the outer range of the lower Himálaya.

Dúns.

Of the Dúns or valleys, between the Siwáliks and the Himálaya, that known as 'the Dún' or Dehra Dún, from the town of Dehra, is not only the most remarkable but the best known. Since the physical geography of this tract will be considered in more detail hereafter, in the notice of the Dehra Dún district, it will be sufficient for our purpose here to note that the Dún, a little to the west of the town of Dehra, is divided by a ridge that serves as a water-parting between the Asan, a tributary of the Jumna on the west, and the Suswa, a feeder of the Ganges on the east. The tracts drained by these rivers are known respectively as the western and eastern Dúns. The two taken together have a length of about forty-five miles and an average breadth of eleven miles. The east end of the Dehra base line of the Great Trigonometrical Survey on the extremity of one of the spurs of the Gháti range, about one mile west of Mahobawála, is 1,957·65 feet above the level of the sea: Mahobawála itself is 2,096·56 feet and Dehra is 2,323 feet. The junction of the Suswa and the Ganges is little more than 1,000 feet above the level of the sea, giving a considerable fall for that stream between Dehra and the Ganges. A well sunk by Mr. Shore, when Administrator of the Dún, attained a depth of 221 feet before a plentiful supply of water was met with, and even at that depth the nature of the deposit was the same as at the surface.[1] The greatest thickness of the deposit is observed near the central ridge. It thins out to the west and east along the course of the Asan and the Suswa, and, according to Herbert, may be observed in the beds of the Jumna and Ganges resting on sandstone. Next, on the west, comes the Kayarda Dún,

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[1] See also Chaps. XXII.-IV. of the 'Manual of the Geology of India,' and Gaz., II., 46.

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[1] The following table shows the character of the stratum, and is reproduced here from Mr. Shore's notes in the Dehra archives compared with Herbert's record as one of the few notices of this character that we possess.

Feet.	Total.	Soil.	Feet.	Total.	Soil.
5	5	Fine black mould, few stones.	9	158	Sand, larger pieces of conglomerate.
4	9	Reddish earth with gravel.	4	162	Do., enormous stones
9	18	Sand, gravel, large stones.	6	168	Conglomerate and gravel.
2	20	Do., with reddish clay.	3	171	Sand, gravel, and conglomerate.
3	23	Stiff reddish clay.	3	174	Blocks of conglomerate.
8	31	Do., yellow clay.	3⅝	177⅝	Sand, gravel, conglomerate.
3½	34½	Sand, gravel, little red clay.	4⅜	182	Do., gravel.
1½	36	Stiff reddish clay.	⅜	182⅜	Conglomerate.
2	38	Sand and gravel.	2⅝	185	Sand and clay.
22	60	Stiff red clay.	18⅞	204	Loose sand and gravel and large blocks conglomerate.
2	62	Clay, sand and gravel.	5	209	Sand, gravel, very moist.
16	78	Sand and gravel.	½	209½	Conglomerate, over half.
12	90	Stiff yellow clay with little sand.	1½	211	Red clay.
35	125	Sand, gravel, few round stones.	7	218	Sand and gravel.
6	131	Sand, large conglomerate blocks.	3½	221½	Brackish clay with angular fragments of clay slate.
13	144	Do., gravel, stones,			
5	149	Do., larger stones.			

Another well in Dehra gives water at a depth of 88 feet from the surface, and one at Sati-bágh at 75 feet. There are only twenty-nine wells in the whole valley, and many of these are at favourable places near rivers, so that the difficulty of procuring water by this means is common to the whole Dún. Herbert records the some six miles broad and twenty-five miles long, to the water-parting between the Jumna and the Kaggar systems. Beyond it we have the Pinjor Dún, which has in parts a breadth of six miles and a length of about thirty miles. The Siwáliks here are neither so broad nor so high as to the south of the Dehra Dún. The Pinjor Dún is divided into two parts, the eastern and western Dúns, by a ridge similar to that observed in the Dehra Dún, and which attains an elevation of 2,402 feet[1] above the level of the sea. To the east, the drainage flows into the Kaggar, and to the west into a tributary of the Satlaj. Mansi Devi, a temple in the plains just within the Dún, has an elevation of 1,263 feet,[1] giving a fall to the rivers within this Dún similar to that found to exist within that of Dehra.

Ganges to the Brahmaputra.

East of the Dehra Dún we have the Pátli Dún, also divided into two parts, but by a depression, not a ridge, a fact possibly pointing to its being a valley of denudation. That to the west, which is drained by the Sona nadi, has a slope eastwards parallel to the Himálaya, and is known as the Kotri Dún. That to the east, which is drained by the Rámganga and has a slope to the west in the same direction, is called the Pátli Dún. The two rivers meet just before their waters take a bend to the south at an elevation of about 950 feet[2] above the level of the sea. A few miles eastward of their confluence, the valley of the Pátli Dún shows an elevation of 1,200 feet on the right bank of the stream, and thus allows a considerable fall to the Rámganga in a comparatively short horizontal distance. The peaks of the Siwáliks to the south along this entire line seldom rise above 2,500 feet, whilst the plains at their southern base average between eight and nine hundred feet. Further east comes the small Kota Dún between

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result of borings made by him in various parts of the tract along the foot of the hills. At Káshipur, in a spot some twenty feet below the surface of the red clay, he obtained the following results :—

2'3" superficial red clay : 1'3" green sandy clay, water : 4'6" black clay, extremely tenacious : 1'6" light blue sand and abundant water. At Haldua, seven miles north, nearly similar results were obtained :—5'6" a ferruginous sandy clay or loam, latterly becoming more stiff : 1'6" a greenish clay, becoming blackish below : 2' a bluish-grey clay, partially sandy, not so tenacious, and quite moist. At Jaspur, nine miles north-west of Káshipur, he found :—5' surface sand, which gradually changed to a stiff red clay : 2' a red, loose sand, damp : 2' variegated sand and clay, spotted : 3' yellowish sand changing to light grey : twigs and roots were found at nine feet and water at twelve feet. At Afzalgarh 6' superficial loam with small nests of imperfectly formed lignite : 2'6" red sand and a quicksand : 4' blackish stiff clay, and 3'6" stiff clay, latterly sandy. Two other borings are recorded without mentioning the locality.

[1] Herbert. *l. c.* art 63.

[2] G. T. S.

Dhikuli and Káli-dhúngi, much broken up by torrents, and having its southern boundary cut through by the various hill streams that cross it at right angles. From Naini Tál to the Sárda the sandstone ridge that represents the Siwáliks is so close to the Himálaya that the geologist alone can discern the connection. The Dúns are here reduced "to deep longitudinal gorges and low gaps, corresponding with a leading geological boundary, that between the old slaty and schistose rocks of the mountains and the massive tertiary sandstones of the Siwáliks." Further east, according to Hodgson, the Dúns are represented by the Saliyán Mári, the Gongtáli Mári, the Chitwán Mári, the Makwánpur Mári, and the Bijayapur Mári, all under Nepál. With the exception, however, of the Dún lying on the road to Kathmándu, none of these have been subjected to scientific examination. "On this track," writes Mr. Medlicott,[1] "very complete representatives are found of the two sub-Himálayan ranges and their intervening *dún* or *mári*. The Chúriagháti range is structurally a facsimile of the original Siwáliks. At the outer base at Bichiyakoh, there are some earthy rusty beds, all greatly crushed. The dip soon settles down to 30° to north-north-west, maintaining the same angle steadily to the top of the pass. This is the typical structure of these detached sub-Himálayan ranges, the flat inner half of a normal anticlinal flexure. The range is about four miles wide." Throughout the Sikkim and Bhután *duárs* there is no representative of the Siwálik hills and therefore no *dúns*, but in the Dikrang basin of the Daphla hills, Colonel Godwin-Austen discovered two well-marked ranges of sub-Himálayan hills with an intervening *dún*. We have now seen that the first characteristic features met with in advancing from the plains to the Himálaya are the Tarái, Bhábar, Siwálik range, and *dúns* or valleys, and that though not continuous and indeed occasionally altogether absent, they are, taking the whole range, characteristic of the relations of the Himálayan mass with the subjacent plains.

Lower Himálaya.

Crossing the Dúns northwards towards the snows, we meet the outer ranges of the lower Himálaya. They have a general elevation of about 7,000 feet above the level of the sea, while the highest summits along the line reach between 8,000 and 9,000 feet. This generalisation, though giving the nearest approach to accuracy that the state of our knowledge permits, is only approximate, for we know very little regarding the outer range between the Sárda and the Brahmaputra. There is this peculiarity in Kumaon, that the outer range first crossed by the traveller is of considerably higher elevation than the intermediate ranges crossed between it and the outlying spurs of the great snowy range itself. We have said that we hold the entire Himálaya to be but the southern slope of the great Tibetan plateau; that however rugged and furrowed this slope appears, it is homogeneous throughout. We reserve for the district notices the purely geographical description, and will here try to answer the questions that naturally arise regarding these mountains as a whole. What have geologists been able to discover regarding their history and the materials of which they are composed, and are the causes at work sufficient to produce such very varied results as are here exhibited? In attempting[1] to answer these questions, we must refer to well-known principles,[2] which have been found true in Europe and apply with equal or even greater force to the phenomena observable in the Himálaya. Without trespassing on the domain of the professed geologist, we may briefly summarise the facts observed regarding the Himálaya as a whole. We have seen that the outer range forms a geological as well as a physical boundary under Kumaon. The whole mountain mass may be divided into three great belts. First, the sub-Himálayan tertiary sandstones outside the Himálaya proper of geologists, and which have a considerable development west of the Jumna. To them belong the Siwáliks and the Sirmúr series on which the hill sanitaria of Kasauli, Dagshái, and Subáthu are built. Secondly, a belt of limestone and slate forming the outer range of the lower Himálaya on which the hill sanitaria of Simla, Chakráta, Masúri, Landaur, and Naini Tál are situate. Thirdly, the crystalline rocks with granitic intrusions that form the remainder of the lower Himálayan region as well as the line of snowy peaks, and across the British frontier to the north of Kumaon, the palæozoic and secondary rocks of Tibet. Thus we have as the materials of the Himálaya the two great classes of rock known as the stratified or bedded and the crystalline. To the former belong the limestone, sandstones, and slates that have been derived from the waste of the older rocks ; and to the latter the granite, gneiss, and schists which occur in masses.

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[1] Manual of Geology. p. 543.

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[1] My acknowledgements are due to the works of Medlicott, Blandford, Tyndall, and Geikie, on which the following pages are based. [2] Though known to every student, a re-statement of these principles seems necessary in a work intended for popular use in India.

Materials of the Himálaya.

The core or nucleus of all great mountain masses is formed of crystalline rocks, while the stratified rocks enter largely into the composition of the lower subordinate ranges. This is true of the Himálaya, Alps, Pyrenees, Rocky Mountains, and indeed of all the great mountain systems. A glance at the geological map given hereafter will show more clearly than any description the arrangement of these rocks in Kumaon. One of the fundamental principles of geology is that the sites of all the great mountain masses of the world at one time formed a part of the bottom of the sea. K2, Nanda Devi and Mount Everest, the last of which exceeds a height of 29,000 feet above the level of the sea, at one time apparently formed parts of the bed of an ancient ocean. For the crystalline rocks have arisen either from the gradual consolidation of materials which had been fused deep within the crust of the earth or from the influence of subterranean water combined with the earth's internal heat, out of earlier sediments such as sea-mud and sea-sand, which in the course of time had sunk down and been covered by many thousands of feet of later deposits.[1] Geologists tell us[2] that while no important movements, except small and partial changes of elevation, can be traced in the peninsular formations of India, the whole of the gigantic forces, to which the contortion and folding of the Himálaya and the other extra-peninsular mountains are due, must have been exercised since eocene times. The sub-Himálayan beds were deposited upon uncontorted paleozoic rocks ; and although a part of the Himálayan area may have then been land, the direction of the ranges is clearly due to post-eocene disturbance. It has also been shown that the movement has been distributed over the tertiary, post-tertiary, and pleistocene periods. It has been suggested that upheaval still goes[1] on, as earthquakes are of common occurrence along the line of the Himálaya and as far westwards as Kábul. Three distinct shocks were felt at Naini Tál in April, 1880, and Srinagar in Garhwál was almost destroyed by a great earthquake in 1803. A recent traveller,

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[1] Professor Geikie on 'Mountain architecture.'

[2] Manual of the Geology of India, *lvi.*

M. Severtsof, attributes the contraction of the great Kára-kul lake on the western Pámír to a similar cause, and says that the connection of the Tián-shán with the Pámír is due to an upheaval which geologically is of recent date and is still progressing. At the end of the cretaceous period and at the beginning of the tertiary period, the Tián-shán was separated from the Pámír by a strait with rocky islands, the marine deposits of which are found beyond the Tuz-Ashu pass. It is startling to the uninitiated to be told that the mighty mass of the Himálaya, as it now appears, is a formation younger than the comparatively insignificant hills of the Dakhin (Deccan) and Central India. The same, however, is said of the Alps, Pyrenees, Andes, and Rocky Mountains, all of which received their chief upheaval in tertiary times.

Eocene period.

According to Mr. Blandford it is probable that the crystalline axis of the western Himálaya which apparently terminates in the Dhauladhár peak, the western extremity of the snowy range seen from Simla, coincides with the shore of the ancient paleozoic continent of which the Indian peninsula formed a portion. If this be a correct view, the cis-Himálayan paleozoic rocks are in a great part of fresh water origin, whilst the marine paleozoic formations are found throughout the extreme north of the Panjáb, Kashmír, and the neighbouring countries north of the Dhauladhár and crystalline axis. In eocene times, the peninsula of India was part of a great continent probably united with Africa. To the east was a great sea extending up the Asám valley along the southern base of the Gáro hills and thence southward throughout a considerable area west of the Irawadi in Barma. There was another sea to the north-west covering a great part, if not the whole, of Persia, Baluchistán, the Indus plain, and extending as far north-east as Garhwál, and an arm of this sea extended up the Indus valley into Ladák. The Himálaya and perhaps Tibet, wholly or in part, were raised above the sea, but there is no evidence to show that they had then attained any unusual elevation. In later eocene times, the Himálaya had risen sufficiently to send back the sea boundary to the north of the Panjáb, and in miocene times, the marine area was still further contracted. The existence of a sea in these places is attested by the presence of marine deposits and shells, and this discovery clearly shows that not only did the sites in which they occur once form the bottom of a sea but that the difference in height now observed between them and the level of the sea must be greatly added to in order to arrive at the true measure of the upheaval that has since occurred. The work of denudation that continually goes on shows us that the present summits of the mountains must in the course of time have lost a considerable portion of their substance, and in the next place we cannot suppose that the marine shells now found lay exactly at the sea level. The bed of the great sea may also have been subject to successive periods of depression and elevation before the eocene period without greatly altering its height. Professor Geikie[1] tells us what the forces are to which these marvellous results are due:—"The upheaval of the sea floor into land seems to have been due to a cause which has been going on from the earliest geological times and which is still in progress. It is believed that originally this planet possessed an enormously high temperature; that, indeed, it was thrown off from its parent sun with a temperature probably even much fiercer than that of the sun at present; and that it has since been gradually cooling and contracting. The external crust of the earth, varying greatly in structure and otherwise, has yielded unequally to the strain of contraction. One result of this process has been the elevation of portions here and there into long ridges, forming the continental masses and mountain chains. You may illustrate this production of lines of elevation along a generally subsiding surface by what takes place when an apple dries. Its surface contracts and wrinkles, most of the skin sinking inwards, but, at the same time, inequally and leaving intermediate ridges to stand up. So in the gradual contraction of our planet, wrinkles have arisen on its surface. It is these wrinkles which form our mountain chains. But such a subsidence of the crust could not have taken place without a very great deal of folding of the rocks. Descending nearer to the earth's centre, the various layers of the crust had a less diameter to fill. They could only accommodate themselves to their new position by being crumpled up so as to occupy less space, or by being cracked across so as to allow some parts to be pushed above others." We find that both these results have been produced, and the records of the Indian Geological Survey teem with illustrations of them.

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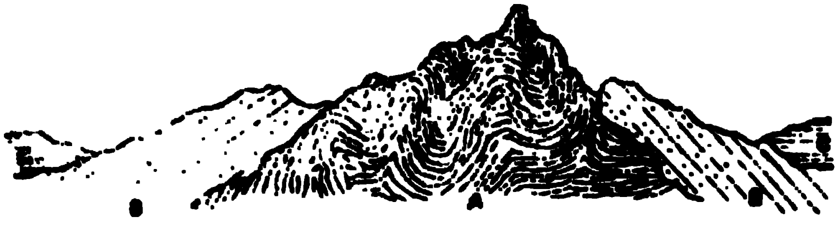
[1] *l. c.*

Mode of mountain formation.

One other fact is noticed, by the same writer, in connection with the crumpling up of the mountains, and that is that this process has been the means of bringing up the crystalline rocks. "Before the time of the crumpling, the whole future mountain area was covered with one continuous sheet of marine strata. But as the mountain chain began to form, the central portions came to be more and more compressed, puckered, and crystalline, some parts being squeezed up, whilst intrusive masses and veins of granite and other crystalline rocks were injected amongst the intensely altered strata along the central nucleus or core. It was during this process, doubtless, that the crystallisation of the gneisses and schists took place, when they passed from their original character of fragmentary (bedded) rocks and assumed the peculiar crystalline texture which they now present." We have already noticed that there have been successive upheavals of the Himálayan mass through the tertiary and post-tertiary and even the pleistocene periods, and the effect of these upheavals on the form of the mountain ranges must have been considerable. Supposing, with Professor Geikie, that a whole mass of sedimentary rocks has been upheaved into land as a mountain chain, we find that "on the outskirts of this elevated area, sedimentary deposits will continue to accumulate in the sea. If in the course of the slow secular contraction of the planet the upraised tract subsides, a new set of strata will be laid down upon the upturned edges of the older rocks. It is evident that in every junction of this kind, some considerable interval must have elapsed between the formation of the older series of rocks A (Fig. 4.) and the newer series B.

FIG. 4.



Section of a mountain chain showing three epochs of upheaval (Geikie).

"In the course of time, the region having once yielded to the strain from terrestrial contraction will probably yield again, and a new upheaval will take place. The series B will now be raised up together with A, and another series C will be laid down in turn upon its edges. Subsequently, the same fate will befall the group C. These three sets of differently inclined strata would fix for us three successive periods of upheaval." This simple explanation shows how very varying must be the results of successive periods of depression and upheaval, and especially when, as in the case of the Himálaya, such an immense area has been subject to disturbance. We have now seen that the primary factor in mountain architecture are the great changes in the earth's crust by which mountains have been formed, and the bedded deposits have become rocks, and eventually, as the process of upheaval went on, have been crumpled, folded, crystallised, and fractured. In this process, lateral pressure has been the chief agent, and this has been exerted simultaneously from different sides in the case of the Himálaya, at least in the pleistocene period. No better examples can be given than those enumerated by Mr. Blandford as characteristic of the western area. Here we have amongst the mountain ridges that encircle the Indus plain and comprise pliocene beds, "ranges running north and south such as the Khirthar and Sulaimán; east and west as the Marí and Bhugti and the Afrídi hills; north-west and south-east as the Pir Panjál; north-east and south-west as the eastern Salt Range and Kharian hills; and many intermediate directions may also be traced, independently of curved ridges." Of the extent of these lateral thrusts an example will be found to the west of the Indus. Taking the Persian area and that of the Himálaya and Tibet, "the mountain ranges fall roughly into two great curves convex to the southward; but the deeper western curve has produced the smaller mountain ranges. That a gigantic lateral movement has taken place in the apex of the western curve is, however, shown by the fact that for nearly 150 miles between Gwádar and Jálk in Baluchistán, the track traverses beds, all apparently of tertiary age, at right angles to their strike and that all these beds are vertical or nearly so. The contraction in breadth, or in other words, the lateral movement must have been great to have converted horizontal formations into a series of undulations, with dips so high as those seen in the Baluchistán ranges." The terms at our disposal to denote the relations of magnitude and adequately to depict the changes that have been wrought during such a period are utterly insufficient to convey a correct idea of what has taken place. Perhaps

Professor Geikie's simile of the dried apple is as far as we can go without entering into scientific details that belong to the professed geologist.

Mountain sculpture.

Only second in importance to subterranean influence in the formation of mountains are the sub-aerial tools of the great sculptor, the different forms of water, ice-wedges, glaciers, snow, rain, and rivers.[1] It is impossible to say what may have been the appearance of the mountain ranges when first formed, but we have every reason to believe that usually the process was gradual and that at once the denuding influence of the different forms of water came into play. Nature from the time the first atmosphere existed has ever been at work tracing lines which gradually work into gorges, ravines, and valleys, weathering peaks and rounding ridges and producing those alterations in the general appearance of the mountains that on a very small scale are familiar to most of us in a neglected hill-station. Both crystalline and bedded rocks abound in joints or divisional planes by which they are separable into blocks and no small part of nature's work in sculpturing mountains is thus rendered possible. Into these crevices runs the melted snow or rain, and there congeals and again expands, forcing the blocks asunder by slow degrees. The sun's rays turn the ice into water during the day, to penetrate still further and again congeal during the night, and this ceaseless process continued for many centuries shows its effect in the form of the mountains composed of even the hardest rocks. These are covered with massive boulders quarried by nature's ice-wedges in this simple fashion. Where the dislocation takes place near the edge of a weathered cliff, the mass of ruin caused by the toppling over of huge blocks is often gigantic. Gerard describes the upper portion of Purgial (Lío Porgyúl) as the "wreck of some towering peak burst asunder by severe frost." Fraser tells us that the summits near Gangotri and Jamnotri are a mere confused mass of huge crumbling boulders, and the same description applies to nearly all the peaks that have been visited by travellers.

Ice-wedges.

Avalanches.

We have next to notice snow in the form of avalanches as one of the tools employed in mountain sculpture. The winter snow, when exposed to the summer sun and influenced also by the heat of the earth itself, is often detached in masses sufficient to cause great natural disturbances. It has been suggested that the change in the bed of the Satlaj in the plains to its present one has been produced by an avalanche in its upper course having dammed up the river. In time the barrier gave way and sent down an immense flood to the plains, sufficient to carve out a more direct course which the river itself has since continued to occupy.

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[1] Acknowledgment is due here to Professor Tyndall's and Professor A. Geikie's mountain architecture.

Glaciers.

It is, however, to the action of snow in the form of glaciers that the more important results are due. These great engines of denudation have the form of a solid river ever progressing downwards through the valleys until the point is reached where the rate of motion is balanced by the melting of the ice. In the figure of the Pindari glacier, given hereafter, it will be seen that the glacier fills the bed of the upper valley and is fed by the drainage of the snow-covered slopes on either side. Its face is discoloured with mud and stones and is utterly unlike one's preconceived idea of masses of ice. Along the sides and edges, too, are rows of earth, stones, and boulders transported and deposited in order by the ice-stream. These deposits are called moraines. Much of the material transported falls down into the crevices and gets between the bottom of the glacier and the rocky bed along which it moves, and which is thus subjected to a grinding process that reduces even the hardest rocks to powder. This fact accounts for the turbid character of glacier streams, especially near their source. The influence of glaciers, therefore, is two-fold, firstly in transporting materials and secondly in reducing them to mud or sand. The combined result is often seen in the mass of detritus heaped up towards the end of a glacier called a terminal moraine, and in the striated and smoothed appearance of the rocks that have been subjected to glacial action. As will be seen hereafter, there is sufficient evidence of a great extension of glacial action in former times that must have had a very important influence on the form of the mountains. Cunningham records three great inundations of the Indus due to the bursting of glaciers in the upper portions of its course. These had dammed up the river bed and eventually gave way, sending a flood down the channel which in the cataclysm of June, 1841, appeared as a wall of water some thirty feet high, destroying every thing that came within its reach.[1]

Rain.

Rain has had even a more constant and penetrating influence on the mountain masses than any of the preceding forms, for it has furnished the materials from which the ice has been formed and is more universal in its operations. The salts and acids contained in it have also had a peculiar action of their own. Rain while falling through the air takes up some portion of carbonic acid and when it reaches a rock dissolves and carries away certain portions of its texture. The result of this process is that not only is the rock reduced in bulk by chemical action but what remains also becomes more easily operated on by the mechanical action of falling water in the next shower. For illustrations of these processes take any line along the limestone ridges about the hill sanitaria already mentioned, and it will be seen how the outer crust where exposed is crumbly to the touch, and has a rough sandy appearance. For those who have seen the long gneissic range extending from Almora to Devi Dhura in Kumaon, there could not be a better example of the influence of rain or rock than is there exhibited. Along the road on each side where the rock has been exposed to the weather, the outer layer is removable by the hand, and at the base will be found a little heap of sand that has been weathered away in course of time. Many of the more loosely formed shales, especially those that contain alum, speedily decompose on exposure to the atmosphere and it is on this account that in the midst of rocky formations in the Himálaya it is so often very difficult to obtain good building stone. Another familiar example of the influence of the rain-fall on the rocks will be seen in the stones of old buildings throughout the hills. Where protected from the weather their surface exhibits the faintest trace of the graver's tool intact, but where exposed they are worn and eaten into and the outer skin appears granulated and rough. This waste of rock material has been in progress for centuries and has produced a soil in which trees have taken root and shed their leaves to produce by decomposition and mixture with the waste the rich vegetable mould that overlies our forest-clad hills. The presence of these trees has had the further effect of retarding the removal of the newly formed soil not only by absorbing a portion of the chemical elements carried down by the rain-water, but also by breaking the force with which the rain would otherwise fall on the soft soil. Thus we find that on well wooded hills the depth of useful soil is considerable and that springs are numerous and abundant. On the other hand where the hills have been cleared of forests, the finer soils are soon washed away by the almost tropical rain. The rocks from which the soil has been formed again appear at the surface and the rainfall rapidly drains off leaving no supply for springs, and if the process be continued over any considerable area, cultivation becomes impossible and the climate is essentially altered. What deforesting has done for Almora can be seen in its scanty rain-fall, its barren slopes, and few springs, although the area affected is so small.

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[1] Ladak, 104 : J. A. S. Ben. X. 617 : XII. 183 : XVII. 230.

Rivers.

The action of a river in the sculpture of mountains is three-fold. First, it has the chemical action of rain in dissolving portions of rock constituents : again, it has in its mountain course the grinding power of the glacier in the force with which it drives the gravel, stones, and boulders along its rocky bed : and thirdly, it has the glacier function of transporting material and laying them down in deposits elsewhere. In the case of glaciers the denuding process is the more important, and in the case of rivers the transporting function has, perhaps, more influence in moulding the features of the surrounding country. In the beds of many of our mountain streams we can detect the action of both glaciers and rivers in the striated and furrowed appearances produced by the former and the rounded forms of worn pebbles due to the influence of flowing water. The muddy colour of the water is due to mud or sand held in suspension, and it has been estimated that in this way one six-thousandth part of a foot is annually carried away from the water-shed of a great river. This waste is, however, very unequally distributed, being very much greater in slopes and valleys and less in plains. "We may be prepared, therefore," with Professor Geikie, "to find that solely by the continued erosion of running water, even the most recently upheaved mountain chains have had stupendous chasms carved out of their sides, and an almost incredible amount of material removed from their surface." Such has been the origin of the Scottish valleys which, according to the same writer, " have been cut out of the general mass of the upraised rock. The existing mountains are what we now find them to be, because they have been left standing while the valleys have been excavated among them." Playfair in his "Illustrations of the Huttonian Theory," as quoted by the same author, writes :—"If indeed a river consisted of a single stream without branches, running in a straight valley, it might be supposed that some great concussion, or some powerful torrent, had opened at once the channel by which its waters are conducted to the ocean; but when the usual form of a river is considered, the trunk divided into many branches, and then again subdivided into an infinity of smaller ramifications, it becomes strongly impressed upon the mind that all these channels have been cut by the waters themselves ; that they have been slowly dug out by the washing and erosion of the land; and that it is by the repeated touches of the same instrument that this curious assemblage of lines has been engraved so deeply on the surface of the globe." In major and minor river systems the same principle is observed ; the lines marking the tributaries of a stream appear like the veins of a leaf all converging on the mid-rib and each forming within its own area a separate main line of a smaller system until the differences are inappreciable. But it may be asked why, if these influences are uniform in their action, the results are so varied. The answer is not far to seek and is to be found in the varied character of the materials on which the aërial forces operate. The southern flank of the Siwáliks below Dehra, consisting of soft sandstones, are weathered by the heavy monsoon rains until they are almost perpendicular. The Krol limestones give their picturesque outline to the outer Himálaya, when compared with the other lower ranges. The shales and slates have a character of their own, and the great crystalline range itself owes its form to the rocks of which it is composed. Kamet has its peculiar pyramidal shape from its cap of granite, and Nanda Devi, Trisúl, and the Panch Chúli have had their peaks defined by simple aërial action on their materials. Thus, our mountain ranges are due in the first place to subterranean disturbances, and in the second place, to the action of the different forms of water, chemically and mechanically, on the varied materials of which the rocks are composed. It is the combination of these two forces that gives such varied results, and until more accurate and comprehensive information is recorded regarding their operation, it is impossible to base our physical description on other than arbitrary grounds.

CHAPTER III.

GEOLOGY.[1]

CONTENTS.

Position of the ground. Early observers: Herbert, Cautley, Falconer. The mountain system. The sub-Himálayan zone formed of tertiary rocks. Siwáliks. Post-tertiary deposits. Supposed glacial deposits. Lower Himálayan region. Simla region. Sirmur formation. Relation of Sirmúr and Siwálik series. The Satlaj valley. East of Simla. The Kumaon section. The Nepál section. Sikkim section. Slight correspondence between the rocks of the Himálaya and of the Peninsula. Frequent occurrence of carbonaceous deposits throughout the Lower Himálaya. Conjectural affiliation of the Lower Himálayan sections. The Central Himálaya. Strachey. Stolickza. Western Tibet. The principal crystalline areas. Nummulitic deposits. Post-eocene eruptive rocks. Central gneiss. Kashmír-Kishtwár region. Central Tibet. Its granites, schists, slates, conglomerates and fossilferous rocks. Palæozoic strata, Silurian. Trias, Jurassic. Fossils. Tertiary deposits. So-called Níti fossils. General Strachey's conclusions. Stolickza's views.

Position of the ground.

THE British Himálayan districts, which form the immediate subject of this sketch, are themselves such a small portion of the immense geological region to which they belong, that we shall have to wander considerably beyond their limits to attain some idea of their place in nature. Some of the ground forms part of one of the best known, and certainly the most widely known, of our Indian rock-formations: the Dehra Dún is pre-eminently the Dún; and the low hills separating it from the wide Gangetic plains are the original Siwáliks, a name to be found in every geological text book. The rocks of the higher hills to the north, below the snowy range, have as yet received only cursory attention, being chiefly non-fossiliferous slates and crystalline schists. On the snowy range and beyond it in Chinese territory we again come upon formations of well-established position, but of which we have little real knowledge, and are altogether dependent upon the occasional observations of a few adventurous explorers.

Early observers.

In geology, no less than in other sciences, it is desirable to be able to trace the stages of knowledge. Even in descriptive geology this information is interesting; and for the student such illustrations are almost essential. Although the germinal idea of geology, that the aboriginal superposition of sedimentary deposits is a sure indication of succession in time of formation, and hence that the structural relations of rocks are the ultimate criterion of age, had to be conceived before geology could have birth. The difficulty of applying this test, of observing obscure and scattered outcrops, and of putting together and discussing the features thus laboriously collected, is so great, that, from the beginning, geologists have sought for, and adopted more ready tests for the chronological classification of rocks. The history of progress in geology is in great measure made up of the failures of generalisations thus too hastily arrived at; the total breakdown of false assumptions, and the correction of errors due to the forced application of partially understood principles; to the neglect of the regulating laws of structure. The science is so young that its history in India affords examples of these errors. In some cases our admiration of the men and the work they accomplished is positively enhanced by our knowledge of the difficulties under which they laboured. The names Herbert, Falconer, Cautley, and Strachey call especially for mention in connection with the ground under notice. Cautley and Falconer will be imperishably associated with the palæontological branch of geology, as having with great labour brought together the unrivalled collection of fossils, the description of which was partially published in the Fauna Antiqua Sivalensis. Work of this kind endures, in so far as it is to a great extent a record of hard facts, having each a permanent interest, such as the existence of a certain fossil within a fixed range of strata. It is not so with facts of the first order in geology proper: the announcement that such a kind of stone occurs in any particular place conveys no information that can be said to have scientific value; it is only when accumulated and colligated under established principles of formation that such petrographical facts come to have any geological meaning. Herbert's observations were of this order. He dealt entirely with unfossiliferous rocks, and the principles under which he had to arrange those observations were still to a great extent artificial; his work has therefore only an historical interest.

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[1] This chapter has been written by Mr. H. B. Medlicott, Superintendent of the Geological Survey of India, for this volume.—E. T. A.

Herbert.

Captain G. D. Herbert, however, must rank in merit as well as by date amongst the foremost pioneers of geology in India. As a man of great talent and of sound and extensive scientific culture, he may stand with Captain

Newbold, who did so much for the geology of Southern India. The advantage of the latter lay in the greater simplicity of the ground he worked in and in his being even a few years later in the field. The mineralogical survey of the Himálayan districts was one of the earliest attempts at a geological map of a considerable area made officially in India. The work was entrusted to Captain Herbert by the Marquis of Hastings; but it was left to private enterprise to make known the results. The publication was taken up by Mr. Henry Torrens, of the Bengal Civil Service, the accomplished editor and proprietor of the so-called Journal of the Asiatic Society of Bengal, which was then brought out at the personal risk and responsibility of the Society's Secretary, and was really the continuation of the publication started by Captain Herbert himself in 1829 with the more appropriate title (under such conditions) of Gleanings in Science. The report appeared as an extra number of volume XI. of the Journal for 1842, nine years after the death of Captain Herbert, and seventeen years after the completion of the survey. The map to illustrate the report was issued with volume XIII. for 1844. It comprises the very large area lying between the river Káli and Satlaj, more than 200 miles in length, and from the plains to beyond the snowy peaks, a breadth of 90 miles. Captain Herbert does not assume any pretensions to authority. He tells us very plainly that he made up his geology for the occasion, but it is plain, too, from his observations and reflections, that he thoroughly mastered his authors. His suggestions in correction of current views are often very judicious, and display a truly scientific turn of mind. His work, nevertheless, can only be noticed in illustration of the history of Indian geology. He divides all the rocks of the mountains into two great 'primary' formations—one for the gneiss occupying the central region, and one for the micaceous, chloritic, hornblendic, and argillaceous schists, to which also he joins the limestones. He makes a third zone of the narrow strip of "secondary rocks, mostly, if not entirely, the Newer Red, or Saliferous Sandstone." On the strength of this purely imaginary identification borings were recommended, if not actually undertaken, along the margin of the plains, to find the carboniferous formation with its coal. This notion was not quite exploded by the discovery of the famous tertiary fauna in a part of the rocks designated by Herbert as New Red Sandstone;

His geological theories.

and by the latest writers, prior to the Geological Survey, the sandstone along the fringe of the Kumaon mountains, and now known as the Náhan or lower Siwálik group, are treated as secondary. The constant dip of the rocks of the southern Himálaya towards the central axis, so marked a feature in their structure, was treated by Herbert in a manner characteristic of the times. His three formations being by assumption successive in order of time, the observed structure seemed to subvert this ordained relation, making the younger apparently pass beneath the older, the schists beneath the gneiss, and the sandstones beneath the schists. He attempted first to explain this anomalous feature by faulting; but when his calculations seemed to demand a fault having a throw of eight miles, he gave up the idea in favour of a supposition infinitely more extravagant. He came to the conclusion that the apparent bedding in each of his three series is not true stratification, due to the process of deposition in water, but only pseudo-stratification, produced by some process of concretionary action; thus, for the sake of a collateral issue, he cut away the very foundations of the science of geology.

Cautley and Falconer.

The work of Cautley and Falconer was the geological converse of that attempted by Herbert. They dealt entirely with one series of rocks, and treated them almost exclusively from the point of view of their fossil contents. The range of their operations was limited to the low fringing hills between the Ganges and the Satlaj. The structural features were very slightly touched upon, the strata being taken to belong to one unbroken formation, which was recognised as of geologically recent date, and as being distinctly made up of the débris of the Himálaya. The following abstract list of fossils will give an idea of the extent of their labours, and of the richness of the fauna they discovered :—

SIWALIK FOSSIL VERTEBRATES.

QUADRUMANA.

Semnopithecus, *Pithecus*.

CARNIVORA.

Hyæna, *Amphicyon*, *Hyænarctos*, *Canis*, *Mellivora*, *Felis*, *Drepanodon*, *Lutra*, *Enhydriodon*.

PROBOSCIDIA.

Stegodon (4 sp.), *Loxodon* (1 sp.), *Euelephas*, *Mastodon* (2 sp.), *Dinotherium* (sp.).

ARTIODACTYLA.

Hexaprotodon, *Merycopotamus*, *Hippohyus*, *Sus*, *Chalicotherium*, *Sivatherium*, *Antilope*, *Cervus* (sp.), *Camelopardalis*, *Camelus*, *Bos* (sp.), *Hemibos*, *Amphibos*.

PERISSODACTYLA.

Rhinoceros (3 sp.), *Antoletherium*, *Equus*, *Hippotherium*.

REPTILIA.

Crocodilus, *Leptorhynchus*, *Varanus*, *Colossochelys*, *Emys*, *Trionyx*, *Testudo*.

Undetermined species of *Aves*, *Pisces*, *Mollusca* and *Crustacea*.

Strachey.

It is to Captain Richard Strachey, of the Bengal Engineers, now General Strachey, Member of the India Council, that we owe the first sound attempt at a sketch of Himálayan geology based upon extensive observation. An abstract of his results was published in the Quarterly Journal of the Geological Society of London for November, 1851, and the map accompanying his paper includes about the same ground as that of Herbert. A comparison of the two maps shows how great an advance had been made. It is greatly to be regretted that official and other business prevents General Strachey from making with his own hand the few corrections and additions necessary to bring his work up to date for the present publication. The annexed map is little more than a reproduction of General Strachey's, and the description also of a large portion of the ground is a reprint of his paper.[1] Acknowledgment is made by him that a considerable portion of the observations recorded were contributed by his brother, now Sir John Strachey, late Lieutenant-Governor of these provinces.

The mountain system.

For the geographer a mountain chain is fixed by the conditions of continuity and direction. The geologist would fain make his mountain systems to depend primarily upon contemporaneity of formation, as suggesting causal connection. From neither point of view can the Himálaya pretend to fixity of limits. On the south, indeed, no great physical boundary could be more marked than the base of the mountains between the Jhelum on the west and the Bramaputra on the east, a distance of about 1,500 miles. The line is remarkably unbroken, without projecting spurs or open re-entering valleys. It has a uniform curve, the bearing in Upper Asám being to east by north, while in the Panjáb it is nearly to north-west. Throughout this entire length the hills rise abruptly from the alluvial plains. The terminations of this boundary are also very well marked. The Asám valley ends against the ranges of the Barma-Malayan mountains, which pass up from the south, at right angles to the Himálayan chain, to coalesce with it in the elevated regions of Eastern Tibet. Similarly on the north-west the ranges of the Sulimán and Hindu Kush pass continuously into the mountain region of Little Tibet, nearly at right angles to the run of the north-west Himálaya. It is on the north that the question of a physical boundary is to a great extent arbitrary. The chain of mountains that, under the name of Himálaya, forms the northern boundary of Hindustan, is in reality the southern face of the great mass of elevated land extending through nearly 30 degrees of longitude, from the sources of the Oxus to those of the great rivers of China, while its northern face appears upon our maps as the range called Kuenluen. To the south lie the plains of India, whose greatest elevation is about 1,000 feet above the sea; while on the north is the Central Asiatic desert, which nowhere is at a less altitude than 3,000 feet. The loftiest summits known on the surface of the earth are to be found towards the southern edge of this elevated region, at least one peak having been measured whose height is upwards of 29,000 feet, while along the whole line peaks of 20,000 feet abound.

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[1] On the Geology of Part of the Himálaya Mountains and Tibet : Quar. Jour., Geol. Soc., London, for November, 1851. Vol. VII.—E. T. A.

Tibetan plateau.

So little is known of the interior and northern parts of this region that it is impossible to offer any general account of it based upon actual observation; but as far as we may judge from those parts that have been explored, it appears that the surface is, with few exceptions, broken up into a mass of mountains, the general elevation of which, valleys as well as ridges, is very great; and there seems no reason for supposing

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that either the Himálayan or Kuenluen have any definite special existence as mountain ranges apart from the general elevated mass of which they appear to be the two opposite faces. The portion of the southern chain to which the following description more particularly refers, is somewhat to the west of a central line, on about the 80th degree of east longitude, which meridian passes through the island of Ceylon, and not far from Cape Comorin. The order of notice will be in successive zones from south to north—the plains, the Sub-Himálayan zone, the Outer or Lower Himálaya, and the Central Himálaya.

The plains.

While difference of opinion exists as to the formation of the most recent deposits, it is not to be wondered at that there is often much doubt as to the origin of ancient formations. The primitive idea that a water-basin is necessary to the accumulation of extensive sedimentary deposits is still widely held. To it is primarily due the not yet obsolete opinion that the plains of India are in great part of marine origin. The only direct evidence in support of this view is the local occurrence of salt-wells, which also involves a popular error, for although the sea is the great receptacle of salt, it is chiefly by rock-decomposition on dry land that salts originate. This fact is likely to force itself disagreeably upon future generations in India ; at present we have only to do with it as at least weakening a mistaken geological position. The only fossil remains found in these plains-deposits are of land or fresh water origin, and these occur even in the delta below the present sea level.

Bhábar.

The surface-form, and the distribution of the materials of these deposits, is, moreover, just what is now understood to be due to the normal action of rivers above their final point of discharge. Torrents, streams and rain-scour from the precipitous slopes have accumulated a wide bank of coarse diluvial deposits along the base of the mountains which is known in these provinces as the *bhábar* or forest zone. In Rohilkhand it is about ten miles wide, and has a fall of from fifty to seventeen feet per mile, and, except in the rainy season, water is not procurable in it. Even considerable streams sink into the porous gravel-beds. Outside the *bhábar* is the *tarái*, also about ten miles wide, in which water is superabundant,

Tarái.

producing swamps and excessive moisture. Formerly it was supposed that this was an area of actual depression; it has, however, a very considerable fall, averaging (in Rohilkhand) more than ten feet in a mile. The moisture is due to the copious re-appearance of the water absorbed at the head of the *bhábar*. From the *tarái* the plains gradually decrease in slope to three or four inches per mile in the deltaic regions.

The Sub-Himálayan or Siwálik zone, formed of tertiary rocks.

A belt of fringing ridges, varying in width and abruptly lower than the contiguous mass of the Himálaya, occurs throughout their entire length, with perhaps two short interruptions in Lower Asám, which are doubtfully and in part attributed to denudation. The pure geographer might, in some places, ignore this feature, as perhaps below Naini Tál and Darjeeling, choosing to regard its representative there as mere spurs of the mountains. Geological observation, however, draws attention to geographical features that might otherwise escape notice, and notes that these so-called spurs will always be found affecting the form, not of spurs proper, but of ridges parallel to the adjoining mountains, and in a more or less marked degree semi-detached from them by a chain of deep longitudinal gorges and low gaps, corresponding with a leading geological boundary, that between the old slaty and schistose rocks of the mountains and the massive tertiary sandstones of these fringing hills.

Divisions of the tertiary series.

From this double consideration the name Sub-Himálaya has been given to these lower ranges and to the rock-series forming them. For the most part these hills are apparent to the least observant traveller, their outer ranges being separated from the inner ones by broad flat valleys, or *dúns*. These more detached ridges have long been familiarly called Siwáliks, a name extended by Cautley from the native name (Shib-wala) of the representative range separating the Dehra Dún from the plains. This name, too, has been hitherto currently applied to the hills and rocks here described as Sub-Himálayan, wherever distinctly recognised. The closer study of this zone has, however, brought to light distinctions involving some difficulties regarding the application of this familiar name. It has been found that there are recognisable divisions in this great series of the tertiary deposits of the Sub-Himálayan hills, and that the younger of these groups contains by far the largest share (if not all) of the well known Siwálik fossils. On this account it was proposed to restrict the name Siwálik to the band in which those fossils occur; but there are good reasons for preferring to continue the extension of the old name, and to indicate the separable geological horizons as Upper, Middle, and Lower Siwáliks. On the small map annexed they are coloured together as upper tertiary.

Supposed key section of unconformable groups.

It was in the ground west of the Jumna, between the Kayarda and Pinjor dúns, where the outer and inner hills are confluent for a length of about forty miles, that the separation of the original Siwálik series into distinct groups was first brought to notice. Throughout the whole cross-section the dip of the strata is inwards, towards the mountains; but along a sharply marked line, continuous through the length of these hills, there is a junction of highly contrasting rocks: the brown and yellow clays, and conglomeratic gravels at the top of the series forming the outer zones of low hills, abut against harder red clays and sandstones forming an inner zone of somewhat higher hills. The feature is nowhere better seen than in the region of the Márkanda, south of the town of Náhan, the capital of Sirmúr. As is generally the case along the junction of rocks of very different textures, the actual surface of contact is concealed by débris; and the appearance suggested by the conformable dips is that the outer rocks pass regularly beneath the inner ones.

Overlooked by early observers.

Such was the view tacitly adopted by the discoverers of the *Fauna Sivalensis*. It was from the same trans-Jumna region, south of Náhan and of this rock-junction, that a very large proportion of the great Siwálik fossils were procured. No particular notice was taken of the striking feature just described; and Cautley accounted for the absence to the east of the Jumna of the highly fossiliferous beds known to the west, by supposing a lesser upheavement of the ground to have occurred in that direction; thus distinctly implying that those beds underlie and are older than the rocks of the cis-Jumna Siwálik range, which he had himself, from fossil and petrological evidence, identified with the rocks at Náhan.

Nature of the unconformity.

Herbert's deliberate rejection of the elementary fact of stratification, to make way for a theoretical difficulty, is scarcely a less remarkable date-mark than the ignoring of so striking a stratigraphical feature by the original explorers of the Siwáliks. The facies of the two contrasting groups, as seen along the boundary, at once suggest that the outer and apparently underlying rocks are really the younger, and this is immediately confirmed by finding that the conglomerates of this group are principally made up of the débris of the contiguous inner strata. Although this latter fact would be somewhat against the supposition, the steep abutting rock-junction would next suggest a fault, along which the lower strata were upheaved on the north, and thus brought into contact with younger beds of the same series. Patient search, however, revealed an exposed section of the actual contact showing the relation of the strata to be quite different from that implied by faulting. The conglomerates were found to rest against a denuded surface of the older group of rocks; the junction being in fact that of an original steep edge of deposition to which an actually overhanging, inverted pitch had been given at many points by subsequent lateral compression.

First inferences from it.

The feature, as thus described, involves much more than simple successive deposition of the groups. It exhibits strong unconformity between them, requiring the older group to have been upraised and deeply denuded before and during the formation of the younger one. Such a relation generally implies a considerable break and lapse of time between the formations, with a corresponding change in their fossil fauna. It is precisely the history of such changes which it is the business of geology to unfold. But to the unfortunate neglect of the simplest stratigraphical observations, fossils from both groups were mixed together in the magnificent collection that lay ready to the hand of the early discoverers. On account of the character and extent of this stratigraphical feature, suggesting that an unconformity of such depth must have a very wide range, it was proposed by the first observer of it to restrict the name Siwálik to the younger formation, and to designate the older rocks, of the inner zone, as the Náhan group. It is the name by which Cautley identified a certain horizon in the series, although apparently assigning to it a position the reverse of the correct one.

Corrected view.

Large as is the gap absolutely required between the ages of the beds actually in contact along this boundary, it was matter of surprise from the first that no trace of so great an unconformity could be found in the immense thickness of deposits to the south of it. From the conglomerates at the junction, southwards to the plains, one crosses a descending section of several thousands of feet of strata without a trace of unconformity: showing either that even at the base of this section the beds of the Náhan group are not represented, or that the disturbance which produced the unconformity along this line of abrupt contact was of such a nature as to admit of continuous deposition within so very short a distance. Ruling ideas at the time were certainly against the latter supposition, that extended observation seems to confirm it. Going westwards along the Pinjor Dún, we find at the Satlaj, on the very strike and extension of the Náhan range, a continuous conformable sequence from the beds of the Náhan horizon into the softer sandstones, clays and conglomerates at the top of the series. The line of disturbance which in the Náhan region resulted in a denuded scarp against which the topmost beds were deposited by overlap, produced in the Satlaj region an anticlinal flexure which must have been so gradually evolved that the deposits accumulating along its southern base were sensibly conformable throughout, although now we find the uppermost conglomerates almost vertical, with a southerly underlie, at the edge of the Dún. Thus it is evident that a well-defined break is not a general feature in the Sub-Himálayan rock-series, and that it would be premature so far to sever such a portion of it by a separate name from the time-honoured Siwáliks. The name Náhan is already current in print, and may at present be understood to indicate lower Siwálik rocks. It is important, however, to point out that the real inference from the unconformable junction is of more interest than the *primâ facie* one; without it we should not have had distinct proof that slow disturbance of great amount took place in the Sub-Himálayan zone during the formation of the Siwálik deposits.

A division maintained through the character of the rocks and fossils: upper Siwáliks.

Although the marked separation of groups suggested by the peculiar feature of the hills between the Kayarda and Pinjor dúns is not maintainable westwards, there is a uniformity of change throughout the series from base to top whereby approximate horizons are assignable. Conglomerates and gravels prevail at the top, variably associated with brown sandy clays. In many clear sections the thickness is quite 4,000 to 5,000 feet. It is not, however, to be understood that the deposits were ever strictly superimposed to that depth vertically. The mode of deposition in successive banks, each trailing upon and thinning out beyond its predecessor, as pointed out above for the section on the Satlaj, must greatly modify the familiar meaning of the word *thickness* as regards *space;* although where such deposits become tilted up by lateral pressure, and exposed along a comparatively shallow section, the appearance is quite the same as if vertical superposition of the whole series had obtained. Nevertheless, as regards *time*, the fullest thickness must be taken into account, for each bed is truly successive to that below it. Even when raised to the vertical, those upper Siwálik strata have so fresh an appearance as to be scarcely distinguishable from the most recent deposits—from the beds of the torrent shingle or of sandy alluvium now accumulating in the dúns or on the plains. The complete justification for their distinction as an upper Siwálik group is found in the few fossils they have yielded, some of which, as *Bubalus palæindicus*, would connect them with the pleistocene deposits of the Narbada valley rather than with the pliocene Siwáliks.

Middle Siwáliks.

The main fossiliferous zone of the Siwálik series constantly occurs beneath the thick mass of deposits noticed in the last paragraph, and it has a fairly characteristic rock-facies of its own. Massive, clear, gray; soft-sandstone is decidedly the prevailing rock; but brightly tinted clays are also often in great force. The large vertebrate remains, although mostly found in sandstone, are certainly more abundant where there are associated clays. Several thousand feet of thickness must also be assigned to this middle Siwálik group. Falconer considered this Siwálik fauna to be miocene, but palæontologists are now decidedly in favour of its pliocene affinities.

Náhan or lower Siwálik.

In conformable sequence beneath the fossiliferous zone we find rocks of the same type, but having a decidedly different aspect—strong sandstones, but of a darker hue, and often highly indurated, with hard clays generally of a deep red or purple colour. Throughout the Himálayan range, east of the Satlaj, they form the flanking ridges close under the higher mountains, and inside the dúns ; or at least they mostly occupy that position, for it cannot be said that middle Siwálik beds do not occur there too, as will be seen from the remarks upon structure. No fossils can be quoted from those beds, but it is believed that some existed in the original Siwálik collections. They would probably be of miocene age.

Horizontal variations in the Siwálik deposits.

One of the most interesting features in these Siwálik deposits is the variation they exhibit in relation to the position of the great river-gorges. This is most marked in the case of the upper portion of the series. The accumulation of coarse conglomerates is immensely greater in the immediate vicinity of the large rivers of the Himálayan system, and, moreover, it is only within the range of those streams that we find the beds of large rounded blocks of quartzite and other hard rocks such as are now brought down by those great torrents. In the intervals between the rivers such conglomerates as occur are formed almost exclusively of the débris of the adjoining hills, the same as are found in the minor streams now flowing from those hills; but in this position sandy clays often form the bulk of the formation. The same influence is observable in the middle group of the series, which is often conglomeratic and gravelly, or almost exclusively sandy, near the main rivers, while away from them the clays are often in great force. These facts are very observable at the Satlaj ; in the gorge above Bubhor the whole of the upper group is coarsely conglomeratic, and the middle one is more or less pebbly throughout, while at seven miles to the north-west the brown sandy clays, in which the fossil *bubalus* and *camelus* were found, form three-fourths of the entire thickness of the upper group. The apparent exception in the case of the Jumna is even a more marked illustration of the fact under notice. The river now flows through the Siwálik range at many miles to the west of the gorge where it leaves the mountains; the fact being that in the elevation of the outer range the

Jumna could not erode a passage through the great accumulation of conglomerates it had formerly discharged in front of that gorge, and which now form the highest summit of the outer range. It had to work round them not in the direction of its near neighbour the Ganges, but towards the region of lesser deposition. Thus the contrast between the Siwálik strata to the east and west of the actual river-passage is so great that it has been questioned if the formations can really be the same. To the east the upper group is made of the hard shingle conglomerates, while on the same strike to the west the conglomerates are composed of local, principally lower Siwálik, débris. In the cis-Jumna Siwáliks the middle group is formed of thick masses of soft sandstones that have yielded very few fossils, while to the west clays occur largely on the same horizon, and fossils abound. The facts indicated in this paragraph are of great importance, as bearing upon the question of the mountain-formation; showing, as they clearly do, that although these deposits, to a thickness of 8,000 to 10,000 feet, are now in many places turned up to the vertical, and even inverted, yet the main features of the higher mountains must have been during the Siwálik period sensibly similar to what they are now.

Structure of the Siwálik rocks.

So far we have briefly considered the original characters of the Siwalik strata: it is necessary now to notice the features induced by disturbance. This has taken place on the grandest scale. On the right bank of the Ganges above Hardwár the gray sandstones of the middle group have a high southerly dip; and this rises gradually, through an enormous thickness of strata, to a nearly vertical underlie in the conglomerates at the outer edge of the range. A section of the same type is splendidly exposed in the gorge of the Satlaj above Bubhor, in the second range of the Sub-Himálayan hills. There is much method in the form of these flexures: they very generally affect the form known as *normal*, *i. e.*, bends in which the dip is greater on one side of the axis, and so called because of more common occurrence than the symmetrical flexure—when both dips are equal—or than the folded flexure, in which the strata on the side of the steeper dip have been pushed beyond the vertical, and so partially inverted. As an almost universal rule in this region, the steep side of these normal anticlinal flexures is turned from the mountains. From this there results the familar conformation of the Sub-Himálayan hills, presenting a scarped face to the plains and a long slope towards the interior valley. These dúns, or at least the flat longitudinal valleys which are the typical dúns, are thus structural features, not mere valleys of denudation ; they rest upon the comparatively little disturbed strata in the hollow of the synclinal flexure. The range separating the dún from the plains is formed by the anticlinal, the steep (outer) limb of which is generally broken up and denuded away, hence the south face of the range presents the scarped outcrop of the beds on the north side of the axis of flexure.

The Nún under Mussooree.

In the inner ranges, where the disturbing action was greater, the normal flexure often becomes folded, with, of course, inversion of the strata. There is an instance of this fairly seen in the Nún stream under Mussooree : below the narrow gorge, through massive sandstones having a steep northerly underlie, there is a continuous section in the low banks showing the sandstone becoming pebbly, then interbedded with thin conglomerates, then with thicker and coarser beds, all having the same high northerly dip. This is undoubtedly an ascending section though apparently, according to the dip, it is a descending one, *i.e.*, the whole series is inverted. To any one who has understood these simple explanations, it will be apparent that if these conglomerates are upper Siwálik, and unless there is a fault somewhere about the mouth of the Nún gorge, the inner Sub-Himálayan range under Mussooree must be in great part made up of middle Siwálik, and not of Náhan beds ; and indeed their character would support that view. If these conglomerates of the Nún are not upper Siwálik they would form a new sub-division of the Náhan group, which could then hardly be classed as lower Siwálik. Similar conglomerates have lately been observed in this inner Sub-Himálayan zone east of Naini Tál. It is however to be remarked that these folded flexures often are attended by great faulting, on such a scale that all appearance of flexure is lost and we only find a section of upper Siwáliks dipping against, and apparently passing under, beds of the Náhan type. There are several grand instances of such faults in the broad area of Sub-Himálayan rocks beyond the Satlaj in the Kángra region and on through the Jamu hills. They run quite straight or in very open curves for several scores of miles, and as the dislocation lessens, the unfaulted flexure is gradually disclosed. The section in the Nún shows us that to the east as well as to the west flexures may take the place of the peculiar unconformable overlapping boundary between the upper and lower Siwáliks described in the Náhan region, where there is no dún. The difference of structure would be such as might result from the presence of some unyielding mass of rock underground in this latter position, preventing the formation of flexures. This Náhan region is in other ways remarkable, as we shall see in following sections.

The form of the structural features prevailing in the Sub-Himálayan zone indicates plainly a thrust from the adjoining mountain mass; and the magnitude of the total movement is astonishing in connection with the reflection made in a previous section, that it must in great part have occurred since the mountain mass had assumed somewhat of its present form; or, at least, that the main drainage system had remained the same throughout.

Distribution of Siwálik rocks.

From what has already been said, a general idea might be formed of the distribution of the different groups of the Siwálik series; but the effects of denudation and other influences remain to be indicated. The chief expanse of the Sub-Himálayan hills and rocks is beyond the Satlaj. From about Pinjor, the lower Himálayan ranges trend northwards towards the lofty gneissic ridge of the Dhauladhár, overlooking the Kángra Dún. The outer range of the Sub-Himálayan is not affected by this change of direction, so that the zone of tertiary rocks becomes permanently widened to about three times the breadth it exhibits along the whole mountain range to the east. In the Kángra region there is a succession of three dúns occupied by conglomerates, separated by ridges of sandstone brought up along great faults. To as far as the Ganges the upper Siwáliks are still well represented in the outer hills; but east of this river, along the whole of Rohilkhand, only remnants of these outer Siwáliks have been observed. They seem to have been mostly denuded away, and one comes at once upon the older sandstones of the ranges immediately flanking the high mountains. This is the case under Naini Tál. The change, however, is not a permanent one; for, again, far to the east, on the road to

Káthmándu, there is a broad outer Siwálik range, formed of soft sandstones and conglomerates, and separated by a dún from an inner zone of lower sandstones. But, again, along the Sikkim and Bhután border, there is no sign of the outer Sub-Himálayan range.

Post-tertiary deposits.

It has been said above that the uppermost Siwálik strata are considered to be of newer pliocene age, and we have seen modern deposits being laid down against them along the base of the hills in the *bhábar* region. In these a fossil village was dug out by Colonel Cautley in the excavations for the Eastern Jumna Canal. They no doubt passed down into beds of the *prehistorical* or *recent* period. Still there would be a great gap left in the sequence of formations—the whole of the pleistocene period, represented in Europe by the drift, and the cave deposits, which for years past attracted so much attention in connection with the discovery of human remains. For some middle portion of that period representatives are found in the Sub-Himálayan zone. They are unmistakably exposed on the Satlaj, above Bubhor, where the hills on either side of the river, to a height of some 500 feet, are capped by clays and coarse conglomerates, resting quite undisturbed on the edges of vertical Siwálik strata, both of the middle and uppermost groups. It is clear that a long time of disturbance and denudation must have intervened between the deposition of those totally unconformable deposits; also that those high-level conglomerates are separated from recent deposits by at least the time it has taken the Satlaj to excavate its gorge to its present depth. These two limiting tests of age are quite as cogent as those applied to corresponding deposits in Europe. Beds of the same age are well exposed above the sanction already described in the Nún river under Mussooree. They are here quite on a level with the summits of the Siwálik hills to south of the Dehra Dún.

Supposed glacial deposits.

The most interesting deposits of this age are those to which a glacial origin has been assigned. It was long since observed that the glaciers of the Himálaya had once extended to a much lower level than they do now. Unmistakable moraines are found in Sikkim to within 8,000 feet of the sea level, the present limit of glaciers being about 14,000 feet. More recently a glacial deposit has been described in the Kángra valley. Enormous blocks of gneiss are freely scattered in the low ground, at an elevation of 2,500 to 3,000 feet, along the whole base of the Dhauladhár range, resting on the Siwálik strata. One cannot well assign a limit to the mass that may be moved by a rush of water on a considerable slope ; but the distribution of these blocks makes it very difficult to account for them by any action of this kind through the existing gorges ; for they occur along the slope of the flanking ridges, seemingly quite out of reach of any possible sweep of the torrents. They are three possible assumptions to account for their position : by supposing the scarp of the gneiss now forming the mountain-ridge to have once extended a couple of miles in advance of where it is now, and so as to bring those blocks within the range of its talus, but in this case the blocks should be found over the intermediate heights, which is not the case; or to admit that the blocks were ice-borne, and not by glaciers, for the blocks are not arranged in moraine fashion, but by floating ice in a lake of that period ; or to suppose that the whole valley and the main gorges were formerly choked up with detrital accumulations to such a level as may have brought these lateral positions within the range of the spill from the gorges, ever overtopping the lower flanking hills. This is by no means a gratuitous supposition, for we find those coarse superficial deposits capping the heights above Kángra fort, on the south of the valley, and not derivable from the Siwálik conglomerates on which they rest. The necessary slope of deposition for such materials, from this position to the mountain range, would give elevation enough there for any observed distribution of the great blocks, by simple diluvial action. This is probably the real history of the case ; but the possible influence of ice action to aid the process is not to be lost sight of. When the Himálayan glaciers reached to 8,000 feet lower than at present, ice-work must have been very active in the Dhauladhár, and its effects very marked in the deposits at the base of the range. All the facts suggest that those high-level gravels are of the same age throughout the Himálayan border, and probably of the same age as the former extension of glacial action ; and it is impossible not to notice the near coincidence of this age with that of the glacial period of Europe. There is no independent evidence of changes of level since the age of these deposits; and it is doubtful how far mere difference of rainfall could count for the change; we should thus be driven to entertain the idea of an ice-age.

Importance of the theory.

The confirmation of this physical evidence of a great phenomenon having affected synchronously so large a portion of the earth's surface would be of the highest importance to geological science. Since the abandonment of the primitive idea that all similar rocks were of contemporaneous origin, we have been at a loss for any test of absolute time-horizons. Within continuous land areas some approach to a judgment can be made by closely comparing series of adjoining sections, but for any distant or detached area we have to trust to palæontology for the homotaxis, or comparative classification, of formations. Palæontological homotaxis, however, implies difference as well as correspondence in actual time relations; and the problem of settling, from fossil evidence only, in which direction the difference should be counted, is an exceedingly complex undertaking. Thus palæontology itself was the chief sufferer by the natural limitation of age-tests for the stratigraphical foundation upon which it was based, and of which it is as yet far from being independent. And as the history of life upon the globe is the object of the highest interest in geology, the check to progress was a very serious one. The occurrence of even one semi-universal phenomenon, leaving such peculiar and well-marked stratigraphical characters as those of an ice-period, would afford an invaluable test whereby to check the direction of growth and distribution of organic forms in all the formations nearly connected therewith.

The lower Himálayan region.

The change from the Sub-Himálayan hills to the outer region of the mountains is always, as has been shown, a more marked feature than the mere difference of height would suggest. The hills of the Náhan zone range from 3,000 to nearly 5,000 feet, while the summits of the adjoining mountain-ridge vary from 6,000 to 8,000. From this to the great snowy range there lies a tract more than fifty miles wide, of deep valleys and narrow ridges, the average elevation of which would be scarcely over that of the border-zone of mountains. This is the region appropriately known as the lower or outer Himálaya. The main watershed of this broad tract of mountains lies well to the north of the line of snowy peaks, and the great rivers traverse the lower hills in very tortuous courses. The configuration stamped upon the area by the denudation from rain and rivers gives very little clue to the rock-structure. Although the general strike of the formations is parallel to that of the range, the composition of the strata is too complex, and the cases of local distortion too frequent, to admit of anything like the regularity of feature that has been described in the Sub-Himálayan zone. One character may, however, be noticed as constant throughout the western part of the lower Himálaya to as far east as the Nepál frontier : along the outermost zone there occurs a strong limestone formation, producing ridges of more rugged outline and having a greater elevation than the hills for some distance to the north of it. Our knowledge of this immense stretch of mountains is so fragmentary that no connected account can be given of it. We can only give a sketch of the four sections that have been even cursorily observed, and offer some conjectures as to their connection. The four sections occur in the Simla region, the Kumaon region, Nepál and Sikkim.

The Simla region.

The first thing to note of the Simla region is that it constitutes the termination of the Lower Himálaya as characterised above. In describing the Sub-Himálayan zone it was noted how from about Pinjor (on the main road to Simla) the boundary of the mountains trended round to the north for about eighty miles, up to the base of the Dhauladhár ridge, which is exactly on the line of the great snowy range, and is structurally its equivalent. Thus, of course, the continuous broad area of lower mountains is cut off. It is important to notice that this is not a freak of denudation, a great bay worn into the mountains by a tertiary sea : were this the case, we should find the successive formations of the area striking out along that curve and abruptly cut off there. The fact is not so. The strike of the rocks bends regularly with the direction of the boundary, thus showing that the entire feature is an original character of the mountain-structure. We have here, in the extinction of the Outer Himálayan region, the beginning of the north-westerly decrease of the Himálayan elevation. The mountains beyond the Ravi, which, in a superficial sense—as being south of the range of maximum elevation—might be held to represent the Lower Himálaya, do not reproduce its characters. Kashmír has structurally more relation to the Central Himálaya than to anything south of the snowy range. This fact of diminishing original elevation comes out very clearly in the peculiar distribution of some of the formations that occur in the Simla region. These have been roughly classified as below :—

Sirmur ... { Kasauli.
Dagshái.
Subáthu (nummulitic).
Krol (? triassic).
Infra-Krol.
Blaini.
Infra-Blaini.
Schists and gneiss.

The Sirmur formation.

The marked change in the surface configuration from the Sub-Himálayan to the Lower Himálayan hills introduces for the most part a total change of rocks. Below Mussooree and Naini Tál, and throughout the whole range to eastward, one steps at once and for good from the upper tertiary sandstone to the much older slaty rocks. It is not so, however, in the region between the Jumna and the Satlaj. The high ridge on which stand the stations of Kasauli and Dagshái is formed of rocks very similar in character to those of the Náhan zone close by ; but the marked boundary separating them is continuous with that forming to the east the separation of the Náhan from the slates. Indeed even here, under Kasauli, the slates often appear along the boundary beneath the sandstones of the ridge, which have been upheaved upon a basement of their supporting rock. Resting upon the slates in this position we find thick beds of dull brown, gray, and olive indurated clays with bands of limestone, in which there occur abundantly fossils characteristic of the nummulitic period. These beds are well seen about Subáthu. They are overlaid conformably and with alternating transition by red clays with hard purple and gray sandstone, well seen about Dagshái. In the ascending section sandstone prevails to the exclusion of the red clays, as is well seen on the ridge at Kasauli. In these top beds numerous leaves have been found indicating the proximity of an abundant sub-tropical vegetation. The aggregate thickness of this threefold formation (Subáthu, Dagshái, and Kasauli) may be from 2,000 to 3,000 feet. Collectively it may be known as the Sirmur series, a considerable part of its area occurring within that State.

Its distribution.

Here, then, at last we have a formation the horizon of which is fixed by a well-marked marine fauna. The Subáthu group at the base of this series is certainly eocene; and considering the perfectly transitional character of the three groups, we may provisionally consider the whole series to be of this age. The study of its position and relations seems to throw much light upon the history of the mountain-system. It forms an almost isolated outlier, caught up on the edge of the mountain-area. Its greatest width, east of Dagshái, is about ten miles. In that direction it stops out along the crest of a ridge at about fifteen miles west of the Jumna; the mode of termination showing that it was effected simply by greater elevation to the east, and consequent denudation. The only other known occurrence of these rocks within the south Himálayan boundary to eastwards is a small patch of Subáthu beds on the top of the ridge east of the Ganges close to the village of Bon in Garhwál. In the far east, however, the nummulitic deposits at the south base of the Gáro hills have a very striking resemblance to the Subáthu beds; but it is doubtful if they were ever connected. To the west, at the Satlaj, the outlier is attenuated to a band a few yards wide—a bottom remnant of the Subáthu beds. These rocks again appear in some force in the ridge beyond, but become gradually depressed in that direction, so that before reaching the Biás the most characteristic bottom group has disappeared. The band as represented by the upper groups is well marked, though very narrow, at the Ravi. The hill station of Dharmsála stands upon it.

Its unconformity to the older rocks.

Some points of interest have been made out regarding the relations between the Sirmur series and the contiguous older formations. There is very deep unconformity: the Subáthu beds do not rest upon the next youngest rock, which is the great Krol limestone, but upon beds which underlie that limestone. This is fully made out. As a natural concomitant, we find that the surface of contact of the two contrasting formations is a very uneven one. On the ridge at Subáthu there are not more than 50 feet of the typical Subáthu beds below the red rocks; while in the valley alongside there must be 600 to 800 feet of this bottom group. These facts suggest proximity to the edge of deposition of the nummulitic sea; and the succeeding deposits, ending in the plant-beds of the Kasauli zone, tend to confirm the view.

Contortion of the slates post-eocene.

It seems, too, that little or none of the contortion which now affects all the rocks had occured before the deposition of the Subáthu beds; for at Subáthu itself a characteristic bottom layer is clearly seen, resting continuously throughout a considerable synclinal flexure upon approximately the same bed of the supporting slates. In agreement with this observation, we now find these rocks to have undergone equal contortion with the slates. The inner boundary of the eocene area is a very broken one; and outlying shreds of the nummulitic clays are found caught up in folds of the slates, as may be seen on the road north of the Haripur rest-house.

Inferences.

All these facts would tend to prove that although some general elevation of the mountain area, involving deep denudation of the rocks, had occurred here prior to the tertiary period, none of the special disturbance characteristic of the existing mountain-system, and so specially marked in this fringing zone, took place till after the deposition of the eocene rocks. The Sirmur series exhibits more intense and varied disturbance than is at all general in the Náhan group.

Relation of Sirmur and Siwálik series.

The relation of the Sirmur to the Náhan group cannot be so definitely made out, as they are only seen near each other along a single steep line of boundary; and the question is, as to the nature of this boundary. The argument for the total separation of the groups in this region appears, however, to be pretty conclusive. Although, as has been said, the rocks of the upper Sirmur groups have a strong lithological resemblance to those of the Náhan group—so much so that the type of the Sub-Himálayan deposits may be said to have set in with the eocenes—the facies of the Náhan and Sirmur groups are so distinct, in close proximity, that there is little ground for considering any parts of them, as represented in this Jumna-Satlaj region, to be equivalent. It is only on the supposition of the boundary between the areas (which is also the chief boundary along the base of the mountains) being a great fault, that the question of correspondence can arise at all. But as this supposition is the *primâ facie* one—the one that would be applied from the accepted interpretation of like boundaries in other mountain regions—it is necessary to state the evidence against it.

Probable unconformity.

Throughout the whole range of the Náhan zone in this region no trace of the very characteristic Subáthu beds has been found, either at the apparent local base of the section, or as a remnant adhering along the supposed fault-ground. In the former position it might be said we should be more likely to find the top rocks of the older group; but this too can be answered negatively: the lower we get in the Náhan group, we find clays to occur more frequently, whereas the Kasauli beds are almost exclusively sandstones. It is also to be noted that no remnant of the Náhan rocks has been recognised capping the Kasauli beds, or otherwise, within the eocene area. No conglomerate has been observed in the Sirmur group. The only position from which the original continuity of the groups, with separation by faulting, could be maintained, would be to assert that, as the actual base of the Náhan group has never been seen in this region, the whole eocene group may be buried beneath it in conformable sequence, or otherwise; and correspondingly, that any trace of the Náhan deposits had been washed away from the present eocene area. So much for the direct evidence. As to the indirect, there is really little, except the fact of abruptness, in the character of the boundary itself to countenance the supposition of a great fault. A straight line drawn from the west end of the eocene area in Sirmur to the small nummulitic outlier east of the Ganges would touch the Siwálik hills south of Dehra; and along the great bay-like course of the boundary, north of that line, there are many sharp changes of direction, such as are not supposed to be compatible with dislocations of such dimensions as would be required in this case. The great faults in the Sub-Himálayan zone were seen to be remarkably straight. The alternative and most probable supposition is that the eocene area was upraised, and something approaching to the present steep edge of contact eroded out of it, before the deposition of the Náhan rocks.

Change of character to the north-west.

It is, however, to be mentioned that far to the north-west there is complete transition throughout the tertiary series, from the Subáthu to the top Siwálik. The partial obliteration of the Sirmur series, as forming a sharply defined zone at the base of the mountains, commences at some fifty miles beyond the Ravi about Udampur. The zone is there more than twenty miles broad, and rocks of Siwálik aspect occur within it. Still as a zone of greater upheaval it is traceable to beyond the Púnch; but before reaching the Jhilam it is quite effaced, the whole tertiary series sweeping across it in an anticlinal flexure. These facts do not in the least disturb our conclusions regarding the relation of the lower and upper tertiary series in the Lower Himálayan region. They only form part of the concurrent evidence that towards the middle of the Himálayan system the elevation was greater, and commenced earlier than in the terminal region. The same fact is emphatically shown in the comparative relation of the Sirmurs to the older rocks in these two positions. In this case there can be no doubt of the deep unconformity in the Simla region—a relation of the same kind as that here adopted for the Sirmur-Náhan relation in the same area. But this feature too is quite changed to the north-west: in the great inliers of old limestone that occur within the tertiary area of the Jamu hills, the Subáthu group, with the same characteristic bottom-bed as noticed at Subáthu, is everywhere observed in parallel (conformable) superposition with the old limestone. It is not indeed proven that this rock represents the Krol formation; nevertheless, the contrast of the stratigraphical relation is most striking.

Older rocks of the Simla region.

We have again to refer to the Jumna-Satlaj ground for the best sections of the next older rocks to the eocene. The peculiarities of this region come out stronger as we recede in time. Its character in the plains, as the present main watershed of Hindustan, is really its least permanent feature: there is some reason to think that the Jumna once upon a time may have flowed towards the Indus through western Rajputána. It can certainly be affirmed that such a course was within the range of the diluvial conditions that formerly obtained in upper India. The peculiar unconformity found in this position between the upper tertiary rocks is not, like the plains' watershed, accidental or temporary, but structural. In the well-preserved sections of the Sirmur group we found in this region the only representative of the eocene period within the Southern Himálaya; and again here we find the best preserved remains of the older formations. This ground too has been examined in more detail, so it will serve as a standard of comparison.

Standard section.

The Solan rest-house on the new road to Simla stands between three picturesque mountains of limestone, more or less isolated in each case upon a base of supporting rock. It is a blue gray stone, several hundred feet in thickness. From its position here we are safe in taking it as the youngest group of the series with which it is connected. It has now for some years been spoken of as the Krol limestone. There is often a band of coarse sandstone at the base of it, which seems to vary a good deal in thickness, often at the expense of the limestone. Below this there is well exposed in this neighbourhood a thick band of black carbonaceous slaty shales, which pass down into similar non-carbonaceous flaggy beds, forming the whole base of the mountains in this zone, down to the lowest levels. At a thousand feet or more from the base of the Krol limestone there occurs in those slaty flags a thin band of compact limestone of clear pink, yellow, or gray tints, often accompanied by a bed of conglomerate, and a white quartzite. This band, though a thin one, seems to be very persistent to great distances; it is therefore important as a well-marked horizon. It has been identified on the flanks of the hills under Simla; far up the valley of the Tons, at the crossing of the Simla-Mussooree road; on the Ganges near Tapuban, and again on the hillside north of the Kota Dún in Kumaon. It is called the Blaini group. The Krol group is traceable eastwards almost continuously, and in about the same condition as at the Krol, through Deoban in Jaunsár to Mussooree and Naini Tál.

Conjectured affinities.

From certain lithological resemblances to the rocks in Spiti, which he had classified from fossil evidence, Dr. Stolickza has conjectured that the Blaini and *infra*-Blaini beds may correspond with members of his Muth and Bhábe series, of upper and lower silurian age; that the Krol group represents his Lilang serice, which is triassic; and that the *infra*-Krol may correspond with his Kuling series of the carboniferous period, in the central Himálaya. But no recognizable fossil has yet been found in these rocks in the lower Himálayan region.

Extension to Simla.

The relation of this series, which forms so continuously the outermost zone of the lower Himálaya, to the metamorphic rocks on the north is very puzzling, yet essential to the explanation of the mountain structure. Some important hints towards it are found in the Simla region. Unless one chances to stumble upon an outcrop of the Blaini group, the flaggy slates of the *infra*-Krol and *infra*-Blaini horizons are indistinguishable. Immediately north of the Krol there is a compressed anticlinal flexure, with elevation to the north of it; so that the slaty rocks occupy the whole ground till we reach the quartzites of Tara Devi and Boileauganj, which dip towards their common synclinal axis at the gap south of Simla: limestone occurs above them on Jatog. These may represent the Krol group. However this may be, there can be no doubt about the identification of the Blaini group on the spur under the Yarrows and under Chota Simla, on the opposite sides of Jako. The thickness of strata above these outcrops, to the top of Jako, would quite carry the section up to the base of the Krol group.

Typical instance of overlying metamorphism at Simla.

An interesting feature of the section is that the rocks of the Jako and Boileauganj hills are highly metamorphic—mica-schists and garnetiferous hornblende-schists with abundance of vein-quartz—while the flaggy slates above and below the Blaini group, all round the west, north and east base of the hill, are as little metamorphic as on the base of the Krol. This is a crucial instance of a phenomenon that meets us far and wide throughout the Himálaya, the superposition of highly metamorphic upon non-metamorphic strata. The metamorphism is often apparently greater than here—we find gneiss instead of crystalline schists at top—while the case for superposition is less distinct; so that it is possible to doubt the fact of its being a normal ascending section; and accordingly this has always been a chief stumbling-block in the interpretation of the lower Himálayan sections. It is the feature that so fatally puzzled Herbert fifty years ago. We shall have to return to the subject presently, and would only remark here that the very instructive instance we have just seen occurs in a much frequented position, where many English people pass many idle hours.

Section a long ridge north of Simla.

The same flaggy slates seem to continue for a long way north of Simla, for the most part with a moderate north-easterly inclination. There are several lines of crush and strain, generally found at the gaps, but apparently unattended by great dislocation, for no new rock appears along these lines. The Blaini group has been identified on the ridge north of Theog bringing in the Krol beds towards Matiáni, where there are symptoms of gradual general metamorphism. At Nágkanda this change is very decided, and here those slaty schists seem to pass into the flanks of Hatu, the top of which is formed of massive beds of gneiss, lying nearly horizontally. This rock is the same as the so-called *central gneiss* forming the southern basement of the great snowy range, where its chief characteristic seems to be the prevalence in it of ramifying veins of albite-granite. These observations have suggested that the Krol beds had here overlapped the slate series, and are in original contact with the gneiss.

Parallel section in the Satlaj valley.

We have now seen a general section up to the great mountain range. It is taken for the most part along the watershed in a north-east-by-east direction from Simla. The apparent simplicity of it is very encouraging; but we have not far to go to dispel this illusion. It may be noted that no limestone appears on this section beyond Simla. The Sháli mountain, however, only a few miles to the west of Matiáni, is made of strong limestone, not unlike the Krol rock, with an accompanying sandstone, and underlaid by flaggy slates like those about Simla. If they are the same, and indeed in any case, their position is somewhat puzzling, for from Sháli they dip eastwards under the schists of Matiáni and northwards down to the Satlaj, where the limestone seems to pass under the gneiss of the Jalori ridge.* It is not merely a case of dipping *towards* these metamorphic rocks; the V-shaped outcrop of the junction along the steep sides of the Satlaj gorge points up the valley, and is more or less parallel to the dip of the strata in both rocks. In the Satlaj valley above and below Suni, close to the north of Simla, the confusion of the limestones and slates is indescribable; and there is profuse trappean intrusion: whereas, on the whole section through Simla, from the plains to Nágkanda, only one small dyke has been observed. The absence of fossils in those limestone and slate rocks makes it almost impossible to settle their stratigraphical relations with any certainty.[1]

East of Simla.

The distribution of these limestones and slates is as irregular to the east as to the north of Simla. The Chor mountain—directly between Simla and Mussooree, and remarkable for being the highest summit (12,000 feet) occurring within such a short distance of the plains—is an isolated mass of gneiss. To east of it the limestone stretches again far into the mountains, along the valley of the Tons, forming Deoban hill; along the Mussooree ridge it occurs frequently, as on the Abbey and Camel's-back hills. On the top of Landaur it is mixed with sandstones, and appears again by itself on the Tapuban point. The Blaini limestone and conglomerate are well seen on the flanks of the Sarkanda summit, and again in the Ganges at the confluence with the Hiunalgár.

The Kumaon section.

In the Kumaon section we still find the limestone and slate rocks fairly represented. The ridge of Naini Tál is a broad synclinal range, with many local fractures and contortions, like its type the Krol range. The strong limestone that forms the summits about the lake is very like the Krol rock. Here, however, and also at Mussooree, there is a good deal of trappean intrusion. In the Syámkhet valley, north of Naini Tál, trap-rock is in great force, and immediately to the north we come upon crystalline schists. Along the heights of Sunthala and Gágar these are gneissose. The dip throughout is at a moderate angle to north-north-east, and about Almora one or more bands of granitoid gneiss occur in these rocks. Its general mode of appearance is that of interstratification with the schists; but in one place it has been described as intrusive, which would establish its character as a true granite. North of this, for some way, there is a reversal of the dip to south-south-west up to a line of trappean intrusion, which has been traced for many miles along the strike. The rocks to the north of this band are of a more varied character; some are slaty; and limestone is of frequent occurrence, often steatitic in the vicinity of the trap. The dip is less constant in these rocks, and their relation to the crystalline schists of the snowy range is not well defined.

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[1] Much detail with suggestive conjectures regarding this region is given in Memoirs of the Geological Survey of India, Vol. III., Part 2.

The Nepál section.

Where we next get a section of the lower Himálaya through the Nepál valley, there is little outward resemblance to what we have seen to the west. The Churia Gháti range, between the plains and the Etounra Dún, is a pattern specimen of the Siwálik type. North of the Dún there is an equally characteristic representative of the Náhan range flanking the mountains. But inside this we no longer find the border mountain-range of slaty rocks capped by plain blue limestone that is so constant to the west of the Káli. We come at once upon schistose rocks. These, however, are not mica schists of the ordinary type, such as those north of Naini Tál. First there are earthy (slaty) schists, some quite black and with carbonaceous layers ; then flaggy quartzose schists, passing up into strong schistose quartzites ; and these are succeeded by a great mass of dense highly crystalline white limestone within three miles from the Náhan boundary. All are more or less vertical and folded with a prevailing northerly underlie, the strike being 15° south of east. Beyond this steep ascending section there is a broad band of still greater disturbance, apparently a synclinal ; for the limestone is variously repeated, and the underlying rocks brought in again. It would seem to be followed in the Chessa-garhi ridge by a crushed anticlinal, about the axis of which there are thick bands of porphyritic gneiss associated with flaggy quartzites. From here there is again a general ascending section through similar flaggy quartzitic schists to the Chandragiri range, bounding Nepál on the south-south-west. This ridge and all those to west-north-west and east-south-east of the valley are made of folded repetitions of one set of rocks, in which a calcareous element is more or less prevalent ; varying from strong beds of pure limestone to earthy schistose limestone, and prominently a thickly bedded fine-grained quartzite, with scanty calcareous bond. The Shiupúri ridge, on the north-north-east of the valley, is of massive gneiss ; schists appearing again to the north in the valley of the Tádi and the Trisúl Ganga.

Possible affinities.

There is sufficient resemblance in the two bands of limestone and the underlying flaggy quartzites of this section to suggest that they are repetitions of the same series ; and this has certain characters of resemblance to the rock-series at the Krol, which admit of our conjecturing their identity. The whole of this Nepál section exhibits an intensity of disturbance throughout, such as has not been observed in any other section of the lower Himálaya. Only one instance of a doubtful trap-rock has been noticed in the above section, in the schists near the outer boundary.

Sikkim section : Damuda formation.

We have one more section of the lower Himálaya to take note of, far to the east, in Sikkim, and still more unlike than that in Nepál to the sections of the north-west Himálaya. It is of the highest interest, because we find here in a recognizable state a formation well known to us in the peninsula of India, thus establishing almost the only link between these separate geological provinces. There are, indeed, the nummulitic deposits resting against the edges of the Deccan trap at the base of the western gháts to compare with the nummulitics of Subáthu, and showing that the Himálayas are younger than the Deccan plateau. But this is a comparatively superficial connexion ; whereas in Sikkim we find a bottom formation of one of the great rock-series of the peninsula, intimately connected with the rock forming the mountains. It is now thirty-one years since Dr. Hooker discovered Damuda fossils near Pankabári, at the foot of the Darjeeling hills ; but it was only in 1874 that an examination of the mode of occurrence of the rocks was made by Mr. F. R. Mallet, of the Geological Survey, who was sent to investigate the prospect of a useful coal being found. He traced the band of Damuda rocks from Pankabári to Dalimkot ; at the Tísta it is nearly a mile in width. In the western Duárs it does not occur, but on or about its horizon there is a new formation, not found in Sikkim, consisting largely of massive dolomite, and called by Mr. Mallet the Buxa series. In 1875, Major Godwin-Austen, who accompanied the expedition into the Daphla hills, found the Damudas again in force at the base of the mountains in Upper Asám, the Buxa series being there wanting. It is, of course, possible that the Damudas may recur to the west also, in Nepál, though they do not appear at the Sikkim end of the frontier, and certainly they are not specifically represented in the section through Káthmándu.

Its condition and position.

Lithologically as well as by fossils the formation resembles its prototype in the Damuda valley, consisting of strong sandstones, gray shales, and coal seams. In some few spots the rocks are so little altered that the resemblance is complete, the coal itself being the only rock that has not escaped modification. It is always crushed to powder, and could only be utilized by being made into bricks. Very often, however, the whole group is as much altered as the contiguous rocks to the north, the sandstones being converted into foliated quartzites, and the shales into splintery slates or carbonaceous schists. The important point to settle is the stratigraphical relation of the group to the other rocks of the mountains. These are, first, a zone of slate rocks, some greenish and slightly unctuous, some ordinary clay state with bands of flaggy quartzite, rarely hornblendic and calcareous, and also rarely carbonaceous. These form the Daling series of Mr. Mallet. Next comes the gneiss of the upper hills : it is distinguished as the Darjeeling gneiss. The dip in all these rocks is into the mountain, and hence the immediate inference that they underlie each other in the above order. Here, then, we find again an instance of the puzzle noticed in the section at Simla, and on which Herbert made shipwreck. Mr Mallet was unable to find any escape from the position ; the Daling beds pass most regularly with parallel interstratification into the gneiss by increase of metamorphism, appearing underneath it all up the gorges of the Tísta and the Ranjít to the north of Darjeeling, but in a more altered condition. Also he found in several clear sections most completely conformable and transitional junction between the Daling and the Damuda beds. Their junction forms a re-entering angle up the Tísta valley ; the Damudas, however, are not known to rise to the surface again in the interior of the mountains. The conviction was forced upon him that they are indeed what they appear to be,—the lowest and oldest rocks of the Himálayan series in this position.

Theoretical considerations.

Yet so great is the prepossession in favour of gneiss as necessarily a fundamental rock, that doubt still prevails amongst those who have not seen for themselves. It may then be well to mention some independent considerations which tend to remove this obstruction to the *rationale* of Himálayan geology. It has long since been shown experimentally that the silicious minerals entering into the composition of crystalline rocks can, through the medium of moisture, be produced under very moderate temperature and pressure ; and, hence, that the hydro-metamorphism to which gneiss and even granite were due need not be a very plutonic operation. Also it can be urged that although when gneiss occurs extensively on the flat, we may be entitled to regard it as a fundamental rock, due to such hypogene action as would require any underlying rock to exhibit as great a degree of metamorphism as itself, yet when we come to mountain formation the case is very different. Here a special concentration of forces has manifestly occurred which may be adequate to the production of this apparently anomalous result. In a recent and very thorough discussion of this branch of geological dynamics we find a direct explanation of our difficulty; that if a mixed mass of strata were subjected to compression, those portions which by position or texture were least capable of yielding, whether by shrinkage or contortion, would have to bear the brunt of the pressure, and to undergo in some other form its effects, prominently in the development of internal heat.[1] In some such way overlying massive strata may have been converted into gneiss, while softer beds below underwent no crystalline metamorphism. If it should be shown, as in the Simla region, that the Darjeeling gneiss is the same as the central gneiss, the above interpretation of the Sikkim section would have to be abandoned.

Slight correspondence between the rocks of the Himálaya and of the Peninsula.

Geologists in India have been long on the look-out for a connecting link between the rocks of the Peninsula and of the Himálaya. So many of the formations in the former region are unfossiliferous, it was hoped that some clue to their homotaxis might be obtained through their representatives in adjoining regions; and although the elevation of those mountains may have occurred in tertiary times, the rocks so upraised might, of course, be of any age. Thus this discovery of the Damudas, as apparently the oldest formation in the Lower Himálaya, at least in the east, comes rather as a surprise. Although the Damuda series is, according to the most recent estimate of its fossils, of lower mesozoic age, its appearance in the field amongst other Indian formations is one of comparative youthfulness. It is, for instance, immensely younger than the great Vindhyan formation, which cover such large areas in undisturbed stratification, but in which as yet no trace of life has been observed, and below which there are several groups of slaty and sub-metamorphic rocks before we come to the fundamental gneiss of the region. However, in these matters, what is, is best; the object being to know what really has occurred. If the Himálayan sections would reflect to the geology of the Peninsula some light in return for that it has now received therefrom, by clearing up the doubts that still exist about the age of the Damuda formation, it is all we could expect.

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[1] See R. Mallet on Volcanic Energy, Phil. Trans., Vol. CLXIII., page 147.

Frequent occurrence of carbonaceous deposits throughout the Lower Himálaya.

There is but one character found almost constantly throughout the Lower Himálayan sections—the frequent appearance of carbonaceous matter. It may be of no great significance, but it is worth notice. Coal-mining had been attempted near Subáthu in the carbonaceous shale of the *infra*-Krol group, or rather where this rock has been compressed and glazed in fault-ground. And this appearance of carbon (some of it as volatile hydro-carbons) with fault-rock is very common throughout the Lower Himálaya. It occurs at Simla, below Núgkanda, at Mussooree, and east of the Ganges. Among the more highly metamorphosed rocks it is represented by graphite, as about Almora. Its appearance in the Káthmandu section, at the outer fringe of the mountains, next the tertiary sandstones, is about the only specific similarity between this section and that in Sikkim, where carbonaceous matter occurs in the Daling and theBuxa, as well as the Damuda horizon. It may provisionally be taken as a suggestive link of affinity between all these rocks. In this connection it is important to recall that in Dr. Stolickza's independent classification the *infra*-Krol horizon corresponds with his Central Himálayan Kuling series of carboniferous age, which is also the age assigned by some to the Damuda formation.

Conjectural affiliation of the Lower Himálayan sections.

From what we have seen of the rocks of the Lower Himálaya, there is not much prospect of a near solution of this question. The main hope is in the present manifest want of information. Immediately west of Sikkim comes Nepál, taking up the whole middle region of the Himálaya for 500 miles in length, and which through the unaccountable forbearance of our Government, is as much a forbidden land to Europeans as is Chinese Tibet. Except on the single track to Káthmándu, which has lately been traversed by a geologist visitor to the Resident, no Englishman dare set foot in Nepál, whose people are entirely dependent upon our good will for communication with the outside world, and freely enjoy it. In the section to Káthmándu, which is only thirty miles from the plains, we have seen a general resemblance to the rocks of the Simla region, the contrast being chiefly the universally high dips and general metamorphism. Except in this latter character it has little in common with the Sikkim section; specific resemblance in the two rock series cannot be made out. The great limestone has no equivalent in kind in the whole of Sikkim. Where distances are so great, much allowance must, however, be made for probable original change in the nature of synchronous deposits. The fact that the present base of these eastern Himálayas adjoined, or indeed formed part of the Damuda land surface, suggests a difference in the deposits near it from those at a distance. We have also had to notice all through our sections a disposition in the Krol limestone to pass into a sandy rock. In some such manner it may yet be shown that the Darjeeling gneiss is on the same horizon as the fine calcareous schists of the Nepál valley. Every geologist will understand the very precarious nature of such a speculation. As an object to confute, it may be of some service.

Consist largely of well-known formations.

The Central Himálaya.—In treating of the Lower Himálaya we have had almost entirely to depend upon local names for the various rock groups, and to be satisfied with conjectural identifications of them in different parts of the ground. This unsatisfactory result is owing to the want of fossils. For a great part of that ground it must be a permanent difficulty, owing to the high state of metamorphism of the rocks; but there are large tracts where this condition does not obtain, and where we may hope that fossils will yet be found. At the snowy range and over a large part of Tibet the case is quite different. There numerous zones of strata are identifiable, not only locally, but in the established scale of formations, by the presence of well-known fossils.

Strachey, 1848-49.
Stoliczka, 1864-65.

Our information of those regions is, however, in a very fragmentary state, and must long remain so, owing to the inaccessibility of the ground and the rigours of the climate at such great elevations. Numerous travellers have crossed the mountains in various directions, and have brought back a few fossils and isolated observations of the rocks, but only two observers have given a connected geological description of any considerable area. One account is of a portion of Central Tibet in

Chinese territory, north of Kumaun visited by Captain R. Strachey, R.E., 1848 and 1849. The description is quoted *in extenso* from his paper, the map attached to which is reproduced to illustrate this chapter. The second and fuller account is that of Western Tibet, by Dr. Stolickza, published in the fifth volume of the Memoirs of the Geological Survey of India. In the summers of 1864 and 1865 he explored the region between Spiti and Drás and the Indus. It will be recollected that he died in June, 1874, after crossing the Kárakoram pass, on the return journey with the mission to Káshgár, having lost his life through his zeal for scientific research. His observations on this expedition complete a rough section across the whole Tibetan mountain region from the Panjáb to the plains of Khotan.

Western Tibet.

Dr. Stolickza's list of formations, observed in Western Tibet, is as follows :—

	Age.	*Group.*	*Fossils.*
IV.—RIVER AND LACUSTRINE DEPOSITS.			
III.—TERTIARY.—	Nummulitic ...	Indus or Shingo Beds ...	*Nummulites.*
II.—SECONDARY.	Cretaceous ...	Chikkim Beds	...*Rudista* and *Foraminifera.*
"	Jurassic (Upper).	Gieumal Sandstone	...*Avicula echinata.*
"	Jurassic ...	Spiti Shales (Braun Jura).	*Ammonites macrocephalus Parkinsoni, triplicatus, etc.*
"	Middle Lias ...	Upper Tagling Limestone.	*Trochus epulus, Chemnitzia undulata, Terebratula sinemuriensis.*
"	Lower Lias ...	Lower Tagling Limestone.	*Terebratula gregaria* and *pyriformis, Rhynchonella Austriaca, Belemnites.*
"	Rhætic ...	Para Limestone	...*Megalodon triqueter. Dicerocardium Himalayense.*
"	Triassic (Upper).	Lilang series	...*Halobia Lommeli, Ammonites floridus etc.*
I.—PALÆOZOIC	—Carboniferous,	Kuling series	...*Productus semireticulatus, Spirifer Keilhavii, etc.*
"	Upper Silurian,	Muth series	...*Tentaculites, Orthis etc.*
"	Lower Silurian	Bhábeh series	...*Orthis?*
GNEISS, METAMORPHIC SCHISTS, etc.			

Synclical basins.

The distribution of these formations, though subject to many local irregularities, exhibit well the general structural features of the region. There are two main synclinal rock-basins, along the centres of which the younger members of the sedimentary series, with one important exception, are found. These geological features have no superficial relations to any geographical basins. The Indus receives a great part of the drainage from both areas in this region, flowing nearly along the intervening anticlinal axis. The southern basin is best exhibited in the Spiti valley, where the fullest section of the upper secondary formations is found. The northern synclinal-basin forms the Kárakoram range. This latter ground has been very little searched, and as yet neither oolitic nor cretaceous strata have been observed in it. Dr. Stolickza describes the Kárakoram pass as formed of liassic rocks resting upon trias.

The principal crystalline areas.

These long rock-basins are bounded by parallel areas of crystalline metamorphic rocks. The southernmost of these is that already spoken of as the central gneiss. Its peculiarity, as compared with the other crystalline ridges, is that we seem to have here what may'be locally called the fundamental rock. On Dr. Stolickza's type section at the Bhábeh pass, and in General Strachey's ground, 200 miles to the east, the *infra*-Silurian rocks in a non-crystalline state, and of great thickness, are represented as overlying the gneiss. There is no doubt a parallelism of strike in the two contiguous rock-systems, but the condition suggested or implied is that the conversion of the gneiss is of pre-Silurian date; although, in the east at least, granite seems to penetrate both formations. It was in this sense of *basal* that Dr. Stolickza applied the word *central* to this gneissic axis.

Middle crystalline axis.

The gneiss and schists forming the middle region of the mountain mass, from 70 to 80 miles wide at the Pangkong and Moriri lakes, are described of a quite different type, as being largely syenitic, and as more or less made up of metamorphosed Silurian rocks. Along the north outcrop of the southern synclinal basin even the zone of carboniferous rocks is hardly recognizable, and all below it is converted into crystalline schists and gneiss, the south-westerly dip continuing in these rocks up to the Indus: similarly along the north-east side of this gneissic mass the carboniferous formation is the first that is clearly recognizable; all below it being strongly foliated and mineralized, passing with a north-easterly dip under the Kárakoram synclinal basin.

Northern crystalline axis.

The gneissic axis of the Kuenluen is also described as formed chiefly of syenitic gneiss and quartzose and chloritic schists, the relation of which to the adjoining slates has not been made out. Carboniferous rocks with fossils have been observed on both sides of the range. On the northern flanks of the Kuenluen, triassic and cretaceous deposits are the only secondary formations noticed by Dr. Stolickza.

Peculiar position of the nummulitic deposits.

Some minor features in the distribution of the several formations will be mentioned presently. We must first notice the remarkable exception, already mentioned, in the general arrangement as above sketched. The nummulitic formation occurs in great force in the Central Himálaya of Ladák, but not even approximately in sequence with the next oldest group. The cretaceous deposits are found capping the sedimentary series in the centre of the southern synclinal basin; but no trace of nummulitic beds has been noticed near them. These occur in force along the valley of the Indus, in the centre of the middle gneissic area. Dr. Stoliczka remarked how strongly the rocks resemble these of the same eocene age at the south margin of the mountains, especially those of the Dagshái and Subáthu groups. It may also be noticed how similar the statigraphical conditions are in both positions. In the Simla region we saw that the Subáthu beds were deeply unconformable to the contiguous formations, the youngest of which is thought to be triassic. In the Central Himálaya the unconformity is even more striking, because the upper secondary period is well represented, yet the succeeding lower tertiary rocks are in a totally independent basin of deposition. Stoliczka estimates their thickness at 5,000 feet.

Extensive post-eocene eruptive rock.

There is yet another formation to be mentioned in the Central Himálaya. We have seen granite in connection with the central gneiss. Stoliczka frequently notices greenstone as locally associated obscurely with the Silurian rocks; and intrusive trap (much of it of presumably tertiary age) is occasionally, as has been said, very abundant in the lower Himálayan rocks. There is, however, one exhibition of eruptive rocks in the Central Himálaya that calls for special notice. It occurs in the middle gneissic zone, locally forming the axis of a mountain range. It is more than ten miles wide at the Hanlo valley, and is continuous thence, with a variable thickness on the south edge of the eocene rocks, to Kargil. Stoliczka describes it as an epidote, diallage and serpentine rock. It appears to be, at least in part, the same rock which he speaks of as syenite to the west of Kargil, where the nummulitic rocks stop out. The eruptive rock there gets entangled in silurian schists, and becomes quartziferous. This igneous rock strongly affects the eocene strata and is therefore of younger date, and is probably connected with the similar rock described by General Strachey on the same strike far to the east. We were able to draw some very instructive warnings from errors of the early school of Himálayan geologists, so we must not let the moderns escape the same ordeal. On Stoliczka's first visit he did not recognise the rocks on the Upper Indus as nummulitic. In that position they are considerably altered, and he took them to be a very old formation. In then writing of the contiguous eruptive rock, he remarked (*l. c.*, page 128): "From their dark colours these rocks have sometimes been referred to *basalts*, but they have certainly nothing to do with these more recent volcanic rocks." His next season's work proved that they cannot be older than middle tertiary, and therefore much younger than the great basaltic formation of the Deccan. The idea of the lithological criterions of age in eruptive rocks has still a strong hold upon the German school of geologists.

Range of the nummulitics.

It cannot be supposed that the rough cross section we have sketched near the west end of the Tibetan mountain mass can be taken as a type for the immense region to the east. Already within known ground, some interruptions can be pointed out to the longitudinal extension of the several structural zones. Of the continuation of the Kárakoram and Kuenluen, and even of the middle gneissic range, we may be said to know nothing. Stoliczka describes the nummulitic band as completely stopped out against the syenite at Kargil; and although this obtruding rock is at least in part of later date, it is suggested that the termination of the eocene beds here is probably aboriginal. The eastern extension of these deposits is quite unknown, save that nummulitic strata occur in the far east north of Sikkim. Some doubtful observations of them in the Changchenmo valley and about the Pankgong lake are recorded.

Range of the southern basin.

The southern synclinal basin of secondary rocks, continuous for 200 miles from Spiti to the north-west, is also interrupted in the Kargil region against an upheaval of metamorphosed palæozoic rocks. Any recurrence of regularity in this strike cannot be expected, for the whole Himálayan mountain system becomes confused there, towards the transverse gorge of the Indus, where the stratigraphy is complicated by other systems of flexure. The short break that occurs at the transverse gorge of the Satlaj between the secondary basin in Spiti and the perfectly homologous one to the east, as described by General Strachey, is also due to a transversely obtruded mass of partially metamorphosed palæozoic rocks, through which the stratigraphical continuity is so far maintained.

Extension of the central gneiss.

Although the main elevations, constituting the chain of Himálayan peaks, are sometimes, at least in this western region, formed of the older stratified rocks along the outcrop of the southern synclinal basin, the underlying, pseudo-conformable, central gneiss must be taken as the stratigraphical axis of the range. Stoliczka's type-section of it at the Satlaj and the Bhábeh pass is on the actual continuation of that described by General Strachey to the east, in a more central portion of the great Himálayan chain, where these gneissic rocks are much more prominent. The connection of this gneiss of the main chain with that forming the core of the ridges to the north-west of the Satlaj has not been proved. There are three such ridges. On the direct line of the great chain there is the Dhauladhár ridge, having an axis of coarse gneiss, with slates (probably silurian and lower) resting high on its northern shoulder and passing down into the valley of the Rávi in Chamba. But the Dhauladhár is cut off from the Bhábeh section by the deep valley of Kulu, on the upper Biás, where no massive gneiss has been observed. The Dhauladhár ridge absolutely terminates at Dalhousie, the slates sweeping round the end of the gneiss at the bend of the Rávi. Again, Stoliczka observed his 'central gneiss,' though greatly reduced, north of the

Chínáb, at the southern base of the Zánskár ridge, below the Báralácha pass. But on the south of the Chínáb valley, on the northern flanks of the Rotáng ridge, he observed slates which he conjectured to be continuous with those of the Bhábeh pass ; in which case the gneiss of the Zánskár ridge can hardly be continuous with that of Bhábeh section. This ridge of the Rotáng pass is apparently from the maps the structural continuation of the Pir Panjál range, in which a coarse gneiss is again prominent. These three ridges are in a manner confluent in the mountain region of Lahul and Vazíri-Rupi, from which flow the head-waters of the Chínáb, the Rávi, and the Biás. The Bhábeh gneiss strikes into it from the east. Thus it would seem as if the main Himálayan axis broke up into three minor features of the same type in its extension to the north-west.

The Kashmír-Kistwár region.

The gneiss of the Pir Panjál passes beyond Kashmír towards Kaghán. But north-west of Kashmír, at the Zojila, the gneiss of the Zánskár ridge is extinct, the whole range being there formed of the palæozoic schists and triassic limestone, which thus roll over from the Tibetan area into Kashmír. Carboniferous limestone occurs in the valley, striking through the Marbal pass into Kistwár. Eruptive rocks have been frequently observed in Kashmír, but none of later than silurian age. The whole Kashmír-Kistwár region, between the Pir Panjál and Zánskár ranges, is very little known. Its geological affinities are with the Central Himálaya rather than with the region specially designated as the lower Himálaya, east of the Satlaj.

Central Tibet.

General Strachey's description of the Central Himálaya, towards the sources of the Indus and Satlaj, is so brief that it can be given in full in his own words, with his summary of conclusions upon the mountain-formation. A few notes are added, giving additional information or suggesting other opinions :—

"Entering the region of the crystalline schists[1] of the great line of peaks, we find the strike still remaining the same, with the dip pretty constantly to the N.-N. E. Along the lines on which the points of greatest elevation are found in this part of the range, we invariably see for a breadth of several miles, veins of granite in great abundance penetrating the schists, often cutting through them, but perhaps most frequently following the bedding of the strata, between which they seem to have been forced. The great peaks are, I think, in almost every case composed of schistose rock, but the granite-veins may be most clearly seen on the faces of the mountains to very great elevations. Kamet, one of the highest of the peaks in this region, seems, however, to be among the exceptions of this rule ; its summit, which is upwards of 25,500 feet above the sea, appearing to consist of granite alone. This line of granite seems to be subdivided into several branches, distributed generally along the strike, but otherwise not very regularly (see map). It appears to consist, where I have seen it, almost entirely of veins of moderate size, and such is probably its general character in the portion of the mountains between the Satlaj and the Káli ; but the veins occasionally expand into masses of considerable magnitude, and more rarely large outbursts are met with that constitute whole mountains. In the vicinity of the peak to which I have just alluded, Kamet, the granite-area is very large (see map), and a similar development of it also occurs in the vicinity of Gangotri, at the source of the sacred branch of the Ganges. The vein-granite is usually large-grained with schorl-crystals. It is very hard and durable, neither it nor the schists that accompany it being at all liable to decay. The felspar of all granites that I have seen in these mountains is white, and kyanite is of frequent occurrence in the veins.

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[1] The term *crystalline schists* is often used, as above, to include gneiss. General Strachey hardly uses this latter word, which is now so much applied to distinguish the felspathic and often massive form of metamorphic rock. It is probable that some, at least, of the granite of General Strachey's description is really massive gneiss.

Granite.

"The schists that accompany this granite are very hard and crystalline, and comprise all varieties of mica-schist and gneiss. Beds of highly crystalline limestones, some pure, others hardly to be distinguished by sight from mica-schist, are of frequent occurrence, and a band of such rocks seems to traverse the country near the line of greatest elevation. The strata, where penetrated by the granite, are often very much contorted, and the dip appears on the whole to increase as we approach the granite, where it reaches an angle of 45°, which it does not often exceed. Thermal springs are met with in many of the valleys along the line of granite, and in several

Schists.

that I am acquainted with the temperature seemed pretty regularly to be about 128° Fahr. The whole of the appearances presented by the granite and crystalline schists of the great line of peaks in this part of the mountains seem to be universally repeated throughout the whole length of the chain when we reach the region of maximum elevation ; and as we extend our examination, we still continue to find additional reasons for concluding that the general geological phenomena of the range, and the causes that have produced them, remain very similar over great distances.

Slates and conglomerates.

"In immediate succession to the crystalline schists penetrated by granite veins, we here come at once upon slaty beds overlying them, along the bottom of which, near the mica-schists and gneiss, is a line of granite-veins differing somewhat in appearance from those of the larger eruption, and not producing any great alteration in the slaty beds themselves, as is shown by the occurrence of a coarse conglomerate, the component parts of which are perfectly distinct, only a few feet above the granite. Sufficient change, however, has taken place to prevent our distinguishing much more than that the constituents of this rock are chiefly quartzose, and that it contains rounded stones of all size. I have met with this conglomerate in a similar position, and with much the same general appearance, thirty miles or so further to the east. Above these are slaty beds, in all perhaps 9,000 feet in thickness, consisting of coarse slates, grits, and limestones, all more or less affected by slaty cleavage, and all devoid of fossil remains.

Fossilliferous rocks.

"It is after reaching the top of these strata, which is rarely done at a less elevation than 14,000 feet above the sea, that we at length enter again a region of fossilliferous rocks, which extends as far as my examinations have been carried. And it is not a little wonderful to find at this immense elevation a regular succession of most of the more important formations, from the Silurian to the Tertiary Periods. The Palæozoic beds met with immediately above the slaty rocks I have just mentioned seem to have a thickness of about 6,000 feet, but it is quite possible that organic remains may extend lower than I supposed ; indeed, from the very difficult nature of the country, the precise thickness of the deposits and the limits of the different formations cannot be determined properly without a much more careful examination of the country than I was able to give it. The lower portion of these strata are undoubtedly of lower Silurian age, and I am indebted to Mr. Salter for the following list of the species that he has been able to recognize on a somewhat cursory examination of my specimens.

"Among the Trilobites are—*Cheirurus* (the Silurian form of the genus), *Lichas*, *Amphus* (only as yet found in Lower Silurian beds), *Illænus*, *Calymens*, *Prosopiscus*, *Sphærexochus*.

"Of Molluscs are—*Strophomena*, a strongly ribbed *Orthis*, *Terebratula*, *Leptæna* very like *L. depressa*, *Lingulla*, *Orthoceras*, *Cyrtoceras*, *Lituites*, *Theca*, *Bellerophon*, *Murchisonia*, *Pleurotomaria* *Raphistoma*, and *Ctenodonta*.

"Of Polyps—*Ptilodictya*, *Chætetes*.

"Also *Encrinites* and *Cystidæ*, *Tentaculites* and other Annelids and Fucoids.

"I had also an opportunity of showing these fossils to M. Barrande, who appeared to have little doubt, from their general character, that some of the beds from which they came were certainly of Lower Silurian age.

Stratification.

"The lowest beds of these Palæozoic strata consist of dark-coloured thickbedded limestones, in some places filled with corals. They are succeeded by limestones mixed with slates, in which were found the strong-ribbed *Orthis*, *Terebratula*, *Lingula*, *Bellerophon*, and fragments of *Encrinites*. Above these come flaggy limestones with grits, that contain the greater part of the *Trilobites*, *Strophomena*, *Leptæna*, *Lituites*, *Ptilodictyon*, *Cystideæ*, and Fucoids. The beds then become more argillaceous, and shales and slates mixed with an impure concretionary limestone follow. In these beds are found *Cyrtoceras* and *Orthoceras*, and amongst the nodular concretions of limestone a *Chætetes* is common. Next in order come dark-red grits, sometimes marly, containing only a few fragments of Encrinital stems. Above these, pale flesh-coloured quartzite, and finally a white quartzite, in neither of which I ever found any fossils, and which form the highest peaks of the ridges composed of the Palæozoic rock. The whole of these strata are in various degrees affected by cleavage and joints, which penetrate all the beds without regard to their mineral character, although in a somewhat less marked degree in the limestones and quartzites. That the general sequence of these strata is pretty regularly maintained, I have seen over a longitudinal extent of about fifty miles, but it appears highly probable that their development has a far greater range, as we shall also see to be the case with some of the other groups of the fossiliferous rocks.

Compared with England.

"Before passing on, I must observe the very remarkable similarity of general mineral appearance that subsists between the Silurian rocks of the Himálaya and of England. The peculiar pale tint assumed by many of these rocks answers most exactly to the descriptions given by Sir Roderick Murchison of the Silurian districts of Wales, and the characters of the concretionary limestones of both countries appear equally to correspond. Even in hand specimens the texture and appearance of the rocks and of the fossil impressions are so similar that they might most readily be mistaken one for the other. In pointing to these resemblances, however, I would not have it supposed that I should wish in any way to set up mineral character as a criterion by which to decide on the age of any rock. Nevertheless, the facts, if they are to be relied upon, would appear to indicate that as we see the conditions of the existence of organic matter to have been generally similar over large areas, or even over the whole earth, during the same epoch, and to have changed with the progress of time, so likewise has it been with the conditions under which the mineral constituents of the earth have been aggregated.

Silurian predominates.

"The Palæozoic strata that I had an opportunity of examining in detail *in situ*, which I have just been describing, appear to be exclusively Silurian, but the existence of rocks of Devonian or Carboniferous age seems to be shown by some of my specimens, not found *in situ*, which contain *Productus*, *Chonetes*, *Athyris*, *Orthis*, *Aviculopecten*, *Spirifer*. I may here be allowed to repeat that the higher portions of the Silurian rocks being usually found at elevations of 17,000 or 18,000 feet, their examination is not a very easy task, and the difficulties occasioned by the great altitude are infinitely aggravated by the confusion into which the beds are thrown by the vast dislocations that have accompanied the elevation of these mountains. In concluding my remarks on the Palæozoic beds I would observe that, as a general rule, to which, however, there are no doubt many exceptions, these rocks are to be found forming the summits of the highest passes between the British provinces of Kumaon and Garhwál and Tibet, which probably average 18,000 feet in elevation, and that the highest points of the ridges on which these passes are found not unfrequently reach nearly 20,000 feet in altitude.

Trias.

"In proceeding along the section, we shall next observe some beds very remarkable from their apparently close similarly to the Trias of Europe. I can now only regret that, not having been sufficiently aware of their importance, their exact relation to the beds below them has not been better made out; but their position in the series immediately above the Palæozoic rocks is at least certain. In one place these strata were found *in situ* intermediate between the Palæozoic and Secondary rocks, but the greater part of my specimens were obtained from fragments lying on the north slope of the Palæozoic ridge, which appears to terminate with a line of fault, to the north of which a cliff of Oolitic age suddenly rises. From these strata I have obtained not less than twenty-five species of fossil shells, which is a remarkable circumstance, considering the small bulk of the specimens that I was able to bring away with me. Mr. Salter, who has been so good as to examine these also, tells me that we have *Ammonites* several, *Ceratites*, *Orthoceras*, *Natica*, *Exogyra*, *Halobia*, (*Avicula*), *Pecten*, *Lima*, *Athyris*, *Waldheimia*, *Rynchonella*, *Spirifer*. The Triassic beds were chiefly dark-coloured limestones and, where seen *in situ*, were associated with shales and dark-red grits, the latter of which seemed very similar to those found near the top of the Palæozoic series. The line on which they were seen was, however, a very bad one for determining such matters, for it was in one of the great valleys, and consequently on a great dislocation where accumulations of débris almost always greatly predominate over rock *in situ*.

Jurassic series.

"In our progress northward, we next come upon the strata that form the representatives of the Jurassic group. As in the Palæozoic beds, so we here find the general dip to be to the north; but it is impossible for me to offer any opinion as to the degree of conformability of any of these deposits one to another, owing to the great disturbances to which they have everywhere been subjected. It appeared to me, however, as probable that in the parts of the mountains that I examined, a great line of fault intervened between the Oolitic and Palæozoic series. The mountain-ridge of Silurian age most carefully examined by me lies generally parallel to the line of strike, and along its north-east face runs a stream separating it from the Secondary rocks, which rise in an almost impassable precipice beyond. The section here exposed must be at least 5,000 or 6,000 feet in thickness, but the difficulties of the route prevented my extending my examinations into the lower beds. The lowest that I reached were of black limestones and shales, with very few organic remains, and those very imperfect. Above these lie several thousand feet of limestones of various descriptions, the rock in some places being almost made up of fragments of shells. Professor Forbes, who has kindly looked over my specimens from these beds, is inclined to identify some of the species with certain forms that occur in the Fuller's Earth and Cornbrash of England; and it appears that there is here no representative of the Lias.

Oxford Clay.

"Continuing to ascend in the series, we reach next a large development of dark-coloured shales which abound with remains of *Ammonites* and *Belemnites*, the former usually imbedded in spherical nodules, apparently of much the same nature as the shale itself, but exceedingly compact. The shale is for the most part, on the other hand, very rotten, and the band of country along which it is found is often depressed so as to form a valley, apparently in consequence of this disintegration of the rock. This shale Professor Forbes pronounces to be without doubt of the age of the Oxford Clay, a conclusion indicated by the peculiar forms of the *Ammonites*, two of which seem to be identical with species found in beds of the same age in Kachh and Sind, which have been figured and described in the Transactions Geol. Soc.[1] The existence of these beds in the northern parts of the Himálaya was pointed out by Sir Roderick Murchison some years ago, as proved by the occurrence of some of these *Ammonites*, which he had seen. There is indeed direct evidence of the existence of these Oxford Clay strata for a distance of about 200 miles to the westward of the places where I have myself seen them, and their prolongation along the north of the mountains for 200 miles more in an easterly direction is rendered highly probable by the well-attested recurrence of the *Ammonites* in the eastern parts of the kingdom of Nepál. Although we find stratified deposits apparently lying conformably on the Oxfordian strata, I cannot say anything definite regarding them, as they appear to be almost entirely devoid of fossils. They are very hard and compact, consisting of grits, shales, and limestones, and have not improbably been converted into their present state by the action of eruptive rocks which are of common occurrence in this region.[1]

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[1] N. Ser., Vol. V.

[Subsequent to the publication of General Strachey's papers in the Journal of the Geological Society, a description of his collections of fossils was drawn by Messrs. Salter and H. F. Blanford, and printed for private circulation. The following complete lists are taken from that work :—

Silurian Fossils.

Asaphus emodi.
Illænus brachyonisus.
  Do. punctulosus.
Cheirurus mitis.
Prosopiscus mimus.
Sphæaexochus idiotes.
Lichas Tibetanus.
Calymene nivalis.
Tentaculites sp.
Serpulites sp.
Nautilus ? involvens.
Cyrtoceras centrifugum.
Lituites iuliformis.
Orthoceras striatissimum.
  Do. Kemas.
Theca lineolata.
Bellcrophon Ganesa.
Strophomena trachealis.
  Do. chæmerops.
  Do. umbrella.
  Do. aranea.
  Do. nubigena.
  Do. bisecta.
  Do. halo.
  Do. lineatissima.
Orthis Thakil.
  Do. Tibetica.
Murchisonia Himalensis.
  Do. pagoda
Pleurotomaria turbinata.
Raphistoma emodi.
Trochonema hamifusa.
Cyclonema rama.
  Do. subtersulcata.
Holopea varicosa.
  Do. pumila.
Ctenodonta sinuosa.
Cyrtodonta ? imbricatula.
Lingula Kali.
  Do. ancyloides.
Leptæna Himalensis.
  Do. repanda.
  Do. cratera.
  Do nux.
Orthis compta.
  Do. monticula.
  Do uncata.
Ptilodictya ferrea.
  Do. plumula.
Sphærospongia melliflua.
  Do. inosculans.
Chætetes ? Yak
Heliolites depauperata.

Carboniferous Fossils.

Productus Purdonii.
  Do. Flemingii.
Chonetes Vishnu.
Athyris Roissyi.
Aviculopecten hyemalis.

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[1] In 1873 Mr. T. H. Hughes, of the Geological Survey, brought some fossils from the Milam Pass. They were identified by Dr. Waagen as representing crestaceous, jurassic, triassic, permian, carboniferous, and silurian formations. This brings the series here into fuller agreement with that described by Stoliczka in Western Tibet.

TRIASSIC FOSSILS.

Ammonites floridus.
Do. Aon.
Do. Winterbottomi.
Do. planodiscus.
Do. diffissus.
Do. Gaytani.
Do. Ausseeanus.
Do. Blanfordii.
Ceratites Jacquemonti.
Orthoceras pulchellum.
Do. salinarium.
Natica subglobulosa.

Exogyra sp.
Halobia Lommeli.
Pecten scutella.
Lima Stracheyi.
Athyris Deslongchampsii.
Do. Strohmeyeri.
Waldheimia Stoppani.
Rhynchonella retrocita.
Spirifer Oldhami.
Do. Stracheyi.
Do. Rajah.

OOLITIC FOSSILS.

Belemnites sulcatus.
Amonites acucinctus.
Do alatus.
Do. bifrons.
Do. biplex
Do. communis.
Do. concavus.
Do. Eugénii.
Do. Gerardi.
Do. Griffithii.
Do. guttatus.
Do. Hookeri
Do. heterophyllus.
Do. Himálayanus.
Do. Hyphasis.
Do. Jubar.
Do. Medea.
Do. Nepalensis.
Do. octagonus.
Do. robustus.
Do. scriptus.
Do. Spitiensis.
Do. strigilis.
Do. tenuistriatus.
Do. torquatus.
Do. triplicatus
Do. Thouarsensis.
Do. umbo.
Do. Wallichii.
Turritella montium.
Pleurotomaria ? sp.
Turbo invitus.
Chemnitzia sp.

Anatina Avaginula.
Myophoria Blanfordi.
Cardium truncatum.
Cyprina trigonalis.
Astarte major.
Do. unilateralis.
Modiola sp.
Nucula cuneiformis.
Cucullæa virgata.
Do. leionota.
Inoceramus Hookeri.
Lima acuta
Do. gigantea.
Do. mitiloidea.
Monotis concenticus.
Avicula echinata
Do. inæquivalvis.
Pecten æquivalvis
Do. comatus.
Do. bifrons
Do. monilifer.
Do. Lens.
Do. Sabal.
Ostrea flabelloides.
Do. acuminata.
Terebratula numismalis.
Do. carinata.
Do. globata.
Rhynconella variabilis.
Do. concinna.
Acrosalenia ?
Pentacrinites sp.]

Tertiary deposit.

"But the most striking feature of the geology of these mountains is probably that which I have next to mention, *viz.*, the existence of a great Tertiary deposit at an elevation of from 14,000 to 16,000 feet above the sea, still preserving an almost perfectly horizontal surface. On crossing the watershed-ridge between the streams that flow to the south into the Ganges, and those that fall into the upper part of the Satlaj to the north, which here constitutes the boundary between the British territory and Tibet (see map), we find ourselves on a plain

120 miles in length and varying from 15 to 60 miles in breadth, that stretches away in a north-westerly direction. Its western portion is everywhere intersected by stupendous ravines, that of the Satlaj being nearly 3,000 feet deep. The sections afforded by these enable us to see that this plain is a deposit of boulders, gravel, clay, and mud of all varieties of fineness, laid out in well-marked beds that run nearly parallel with the surface, and that hardly deviate from a horizontal position. The discovery of the fossilized remains of several of the larger mammalia distinctly marks the Tertiary age of this deposit. The existence of such fossil remains in the northern parts of these mountains had been long known, but we were altogether ignorant of the precise locality whence they came, and had no facts before us from which any conclusions could be formed as to their geological import. The Níti Pass, from which it was said that the bones had been brought, was not the place where they were found, but one of the routes only by which they came across the great Himálayan chain from unknown regions beyond.

So-called Níti fossils.

"Mr. Waterhouse, who has been so obliging as to examine the specimens that I procured from these beds, informs me that he recognizes amongst them the following :—Metacarpal bone and distal end of tibia of *Hippotherium ;* patella of small horse ; distal end of radius of a larger species of horse ; distal half of tibia of a horse of very large size ; part of metacarpal of a horse ; upper end of tibia of bovine ruminant ; dorsal vertebra of a ruminant. Portion of head of an undescribed animal allied to goat and sheep, having, like them, prominent orbits, and the hords above the orbits; but which differs in the peculiar form the bony core of the horns. The horns are remarkable for being placed very near to each other at the base (their upper portions are broken off). There is a specimen in the British Museum, however, from the same locality, of an animal very like this, in which the horns are seen to be short, stout, and slightly bent outwards at the apex. Right wing of the atlas vertebra of rhinoceros ; phalanx of one of the outer hind toes of ditto ? ; and portion of tooth of elephant ? Specimens of the bones of ruminants, pachydermata, and other animals from this district, presented to the Society by Sir Thomas Colebrooke and Dr. Traill, are in the Museum of the Geological Society, London.

Actual site as yet not identified.

"The bones that we have hitherto obtained from these strata are almost all very miserable fragments, so that it is difficult even for the very learned naturalists that I have mentioned to do more than distinguish the genus to which they belong. It is therefore, I am afraid, at present impossible to come to any decided conclusions as to the identity or otherwise of the species here found with those of the Siwálik hills, a question of the greatest interest with reference to all our speculations on the geology of these mountains. The fossil bones I have not seen *in situ* nor indeed, curious to say, could I, in spite of every attempt, learn a definite locality in which any one knew positively that they had been found. But of the general position where they occur there can be no doubt, for, besides the common account of their being found in some of the ravines that traverse the plain, on many of the specimens quite enough of the rock in which they are imbedded has remained to enable me to recognize a fine-grained calcareous conglomerate exactly identical with beds such as I have seen intercalated with the boulder and gravel beds that constitute the mass of the deposit. Hills of limestone rise here and there above the general level of the plain, and it appears as though the calcareous matter derived from them had cemented together portions of the sands and gravels that were deposited near them.

Probably of marine origin.

"The existence of such animals as I have mentioned as being found in these beds being a physical impossibility in the present state of the country, there can be no doubt that the strata have been elevated to their present height from some lower level since the time of their deposition. There is no direct proof that these beds are marine, no shells having been obtained from them, but I think on the whole that the probabilities appear to be in favour of this plain having been a true sea-bottom rather than of having been occupied by a detached body of fresh water. The general extension of some of the older fossiliferous rocks along the northern face of the Himálaya over a great longitudinal distance is a fact of which we have tolerable proof, and it thence follows that the line on which they occur, distant about twenty or thirty miles to the north of the great line of peaks, has probably been a sea-margin from the remotest ages of the earth's history until as late as the Oolitic period at least. So far, therefore, there is nothing adverse to my supposition; nor is the present interruption of the plain any proof that it did not once have a far greater extension. This is sufficiently proved by my having traced these tertiary beds to the very top of the watershed-ridge in the vicinity of the Niti Pass, where they reach an elevation of upwards of 17,000 feet; the summit of that pass being strewn with boulders that appear to be derived from the white quartizite capping the Silurian strata of the neighbourhood. Further, two or three miles to the south of the pass, a detached portion of this deposit is to be seen on the declivity of the mountain, which must have been separated from the general mass by the dislocations that have upheaved the whole country. It is, moreover, to be noticed that there seem to be grounds for supposing that plains, such as I have mentioned, are found in other parts of the chain under somewhat similar circumstances, which may not improbably have once formed portions of the same sea-bottom. The plain of Pámír, so long known from the accounts of Marco Polo, and the existence of which is fully corroborated by Lieut. Wood of the Indian Navy, in his Narrative to his Journey to the Source of the Oxus, may be its representative to the west; while to the east the plains described by Turner as having been passed over during his embassy into Tibet, as well as others mentioned by Kirkpatrick as existing to the north of Nepál, the descriptions of which are quite confirmed by Dr. Hooker, are not improbably of a similar nature. Another argument in favour of the marine origin of this deposit is, I think, also to be derived from the very regular way in which the beds of gravel and boulders are laid out, for which I should conceive that some action like that of the tides would be requisite.[1]

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[1] No notice has been taken of these great detrital accumulations up to this, because they occur on the grandest scale in the regions described by General Strachey; but every explorer in the Ladák country has noticed deposits of the same kind. In many cases they are very recent. The process of their formation has been very well described by Mr. Drew in the Quarterly Journal of the Geological Society for 1873. From the fossils enumerated above, it is, however, certain that some of them are very ancient The fact that General Strachey did not observe the actual site of these bones leaves it open to conjecture whether they may not occur in some disturbed beds more or less covered by these horizontal gravels; for it is very difficult to conceive how any great dislocation or upheaval of the mountains can have occurred without disarranging such incoherent materials. On the other hand, the fact that such large animals as the Yak, the Kiang, the Ovis Ammon, &c., now flourish in the wild state in those bleak sterile regions suggests that a moderate change of climate, without any great change of elevation, might make them habitable for the fauna now found fossil there. No evidence for marine action later than the nummulitic period is known within the Himálayan border.

"I have already mentioned the occurrence of eruptive rocks in the Tibetan plateau. A great outburst, in which are found hypersthene and bronzite, besides syenitic and ordinary greenstones, and various varieties of porphyry, occurs in the vicinity of the lakes which are found at the eastern extremity of the plateau (see map). The greenstone is known to extend considerably to the west, and forms, at an elevation of about 17,600 feet, the summit of Balcha, one of the Himálayan passes into Tibet which I have crossed.

Eruptive rocks.

"Having thus given a general description of the geology of this region, I shall, as shortly as possible, enumerate the chief conclusions to which I have been led with regard to the physical forces that have been called into action in the formation of these mountains:—

General Strachey's conclusions.

(*a*.)—The general extension of the chain along the direction of the strike of the strata is a phenomenon necessarily connected with the action of an upheaving force along a line. This longitudinal action is further evinced by the parallelism of the lines of *eruptive* action with that of the *strike*. The continuance of action of the upheaving forces along the same general line for a vast period of time, with occasional intervals of repose or of subsidence, is indicated along both the north and south faces of the Himálaya. The great depth at which the forces have originated seems to be proved by the regularity of the action along the entire length of the chain, as shown by the elevation of such a ridge as the Siwálik hills.

(*b*).—The granites appear to constitute lines of elevation, not of rupture; but there seems to be no specific action produced by them on the dip of the strata, which they appear to leave generally unchanged.

(*c*.)—The greenstones, on the other hand, usually follow lines of dislocation of the strata, being sometimes apparently contemporaneous, and at others intruded through rocks already consolidated.

(*d*.)—The cause of the general north-easterly direction of the dip is obscure, although its occasional sudden reversal to south-westerly seems to indicate some connexion with the action of an upheaving force from below, or of violent lateral thrust.

(*e.*)—The lines of fracture of the strata are constantly either parallel or perpendicular to the direction of the upheaving force. The positions of the rivers appear to be altogether dependent on the configuration of surface produced by these fractures ; while the configuration of surface, on the other hand, seems to be but slightly affected by the action of the streams, of which there is rarely any visible sign at 200 feet above the present level of the waters, and never to my knowledge above 300 feet.

(*f.*)—The fact of the granite of the great snowy peaks being seen in veins, penetrating the schists up to 20,000 feet, makes it highly probable that the granite must have been injected long before the mountains received any considerable development. That this granite is older than the Silurian period is rendered probable by the comparatively unaltered state of the lower beds of the Azoic slates at the foot of the Palæozic series, where almost in contact with it.

(*g.*)—The conglomerate bed near the bottom of these same Azoic slates shows the proximity of land at the time of its deposit, and indicates that some upheaval of land had already taken place near the present line of great peaks, possibly occasioned by the granite in question.

(*h.*)—The occurrence of pebbles of greenstone in the sandstones along the southern edge of the mountains shows that the exterior lines of greenstone are older than those beds of sandstone.

(*i.*)—The frequent occurrence of boulders of the quartizites, slates, and greenstones of the outer ranges of mountains among the Tertiary deposits of the Siwálik hills shows that the Tertiary ocean washed the foot of those mountains.

(*j.*)—The regular slope of the plains of Northern India up to the Siwálik hills, which rise suddenly from the flat ground, leads me to infer that the sea must have continued to reach at least as far as the foot of the Siwálik hills for some time after their upheavement.

(*k.*)—The rise of the Tibetan plain has not been caused by the granite eruption of the line of snowy peaks. That the greenstone rocks that abound in many parts of it have equally not caused it, is proved by the peculiar nature of the valleys among the hills to the west of the lakes, which must have been laid out level under water; from which it is to be inferred that these eruptive rocks are older than the tertiary beds of the plain. The same thing is shown by the occurrence of worn pebbles of greenstone in the surface of the plain in the vicinity of some of the detached hills of that rock.

(*l.*)—The former extension of the glaciers far beyond their present limits is a phenomenon that may be noticed almost everywhere in these mountains, and may give rise at first sight to an idea that there may here also have been some special period of cold corresponding to the glacial epoch of Europe. But it seems, I think, more probable that this is here only the result of a change of climate consequent on the upheaval of the great plains of Northern India.

(*m.*)—The existence of ancient moraines on the tertiary plain of Tibet proves that the extension of the glaciers is post-tertiary. Now, if we conceive that after the rising of this plain to nearly its present elevation, the sea still continued to wash the foot of the Siwálik hills, as I have already said that I considered likely, it is clear that the climate of the Himálaya would have been far more moist, and that the quantity of snow that fell on the highest parts of the mountains would have been greatly in excess of what now falls there, causing a great extension of the glaciers beyond the limits to which they have now receded."

Remarks on the above summary.

There are several points in the foregoing summary that might be objected to in detail, but it is hardly necessary to point them out. With the much more extensive information now available than was at General Strachey's disposal, one ought to be able to give a more precise account of the phenomenon under discussion. But one lesson of experience is caution. From all sides the geologists of Europe have been for long years hammering at the Alps; yet the mode of formation of those mountains is still a subject of very vague speculation. What then can we expect from our fragmentary knowledge of Himálayan geology? In one respect we seem to have the advantage: the much grander scale on which the phenomenon took place, and perhaps also the less advanced stage of the process, have resulted in a somewhat less complexity of structure.

The process of investigation is to find out as far as possible from these remnants of the formations, and their relations to each other, what were the conditions of the surface at the time of deposition of each, and what successive changes of conditions occurred. Thus General Strachey's observations that the metamorphism of the rocks forming the crystalline axis and the introduction of the granite are of pre-silurian date; that this axis of elevation was a shore of deposition at that time, would be facts of prime importance in the early history of this region. It would give a prodigious antiquity to the beginning of the Himálayan mountain system, for all subsequent disturbances have conformed in elevation with that which produced the gneissic axis. It may be remarked that this view is apparently in immediate opposition to what is now a very favourite theory of mountain-formation—that which connects these areas of special contortion and elevation with a preceding long-continued accumulation of deposits, and accompanying depression, in the same area; whereby through the gradual rise of temperature in the sediments thus sunk to a considerable depth, expansion occurs, and also a softening of the rocks, including a yielding to the horizontal thrust in the earth's crust, thus producing the compression and up-squeezing into mountains of the accumulated sediments.[1] In the simple application of this process the position of greatest elevation should approximately coincide with that of the preceding greatest deposition, and not with the limit of the deposition, as we find it according to General Strachey's observation.

To this objection, and in defence of the theory, it may be very fairly argued, that the line of actual maximum elevation is due to denudation having removed the softer and more broken strata and left the more massive rock; that according to the observation under discussion, the sedimentary series never passed across this primitive gneissic axis; and that the position of greatest elevation (in the active sense of upheaval) occurred about the middle gneissic axis formed of metamorphosed palæozoic rocks, all the once overlying strata having been removed; that but for this result of denudation we should have the crest of the Himálaya to the north of the upper valley of the Indus.

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[1] Notwithstanding the numerous recent claimants to this theory, the mechanical elements of it are essentially those given by DeBeaumont in his Systêmes de Montagnes, p. 1318: the other ideas in it being due to two other equally eminent philosophical physicists, Herschel and Babbage.

The interpretation of the drainage system gives direct support to this view. It is an evident postulate of physical geology that along any line of elevation the drainage is originally transverse. The manner in which this primitive system becomes largely converted into longitudinal drainage lines is explained in every text-book on geology. Now, making the fair assumption that the initial line of elevation coincides with the maximum line of upheaval, the main watershed of the future continent is determined by that initial line, and it is presumably a very permanent feature. Every geography book notes the fact that the Himálayan watershed lies far to the north of what is more particularly described as the Himálayan range, but the line of reasoning we have just indicated would suggest that the real axis of maximum elevation in the Himálayan system may coincide more or less with the watershed. We should thus have two magnificent examples of the process of drainage-conversions above alluded to: the Indus and the Sanpo (Brahmaputra) now flow from about the same central position, having gradually worn back along the line of easiest erosion, cutting off in succession the originally transverse drainage along the whole line.

Stoliczka's views.

The applicability of this theory of mountain-formation to the Himálaya system does not, however, depend upon the correctness of General Strachey's view regarding the exceeding antiquity of the first gneissic axis. The gneiss there in early Palæozoic times may have been a floor of shallow deposition without being a range limiting that deposition. Stoliczka does not adopt this latter view though, leaving it an open question. His own provisional identification of lithologically similar Silurian rocks in equal force to the south of the axis would, perhaps, suggest their original continuity across that axis. He hazarded very few remarks upon the general geology of the Himálaya, wisely postponing such considerations until the data would warrant something definite. He points out that the deposits of carboniferous age, filling only broken ground in variable thickness, represent the close of a general geological epoch. The Permian and lower Trias are not represented. He considers that after the Trias extensive upheavements occurred, laying dry large tracts that have not since been submerged. The Jurassic basin was then approximately defined. The evidence for these conclusions is not given, and they seem difficult to reconcile with the general regularity of succession of the rocks. On his figured sections the Para limestone (Rhætic group) is the only one that exhibits great inequality of distribution, being of considerable thickness on the north side of the basin, and altogether wanting to the south. His remarks would, however, assign at least an early Mesozoic age for the origin of some of the prominent features of disturbance now stamped upon the Himálayan system.

The most notable features in the sequence of formations in the Himálaya is the position of the nummulitic deposits, as already mentioned. They are in greater thickness than any of the older formation sexcept the lower Silurian. Stoliczka speaks of them as having been deposited in the narrow basin where they now lie in the very centre of the mountain region. This view strongly confirms that previously arrived at from the consideration of the same deposits at the south edge of the mountains: that long and extensive denudation of the Himálayan area had preceded the Tertiary epoch. It seems to have been greatest, as would naturally occur, along the centre of the area of upheaval, wearing down to the metamorphic rocks along what may then have been the back of a brord flat tuberence of the earth's crust. A comparatively slight settlement of the area, submerging only the more deeply eroded parts, would then have sufficed for the accumulation of those eocene deposits, and it seems possible that the production of the synclinal basins of the Central Himálaya—as was shown for the contortion of the infra-Krol beds of the Lower Himálaya—did not occur, or, at least, was not stron gly developed till the great compression upheaval in middle Tertiary times.

CHAPTER IV.

The Himálaya.

CONTENTS.

The outer Himálaya. Mountain systems; Jumna; Ganges; Káli. Subordinate boundaries. The Nayár. Western Rámganga; Káli. The snowy range. Axis of highest elevation. The Tibetan plateau. Glaciers. Glacier of the Pindar; feeders of the glacier; moraines; crevasses and ice tables. Glacier of the Kuphini. Motion of the Pindar glacier. Snow-line. Observations in the eastern Himálaya. Observations in Kumaon. Bisahr. Across the snowy range. Kumaon: Garhwál; Kunaor; Western Tibet. Lakes.

The outer Himálaya.

We have seen that the term 'outer Himálaya' has different meanings according to the sense in which it is used. Geographers understand by it all the mountain systems lying between the snowy range and the plains of India, whilst in the western Himálaya geologists restrict its use to the limestone and slate formations that lie between the outlying tertiary series and the central crystalline axis. To the geologist Simla and Naini Tál are situate on the outer Himálaya, and Kasauli and Subáthu are not; whilst to the geographer all these hill sanitaria are on the outer Himálaya. To obtain a correct appreciation of the physical relations of the ranges of the outer Himálaya we cannot ignore their geological affinities, but we have as yet no geological details on which we can rely for the greater portion of their area. For the tract between the Tons and the Káli we have the record given in the preceding chapter and the map that accompanies it. A glance at this map will show us that the main line of gneiss and granite, which is almost conterminous with the region of perpetual snow, is met with between the eightieth and ninetieth mile from the foot of the Himálaya, and at a distance of from twenty to thirty miles south of the Indian water-parting. Between this line of perpetual snow and the plains there are numerous well-defined ranges, some seemingly spurs from the snowy axis, and of which the geological relation is not well established, and others having an apparent separate and independent existence. As we have already noticed, the traveller from the plains meets first an outer range, which has a general elevation of about 6,000 to 7,000 feet above the level of the sea, and which in China above Naini Tál rises to 8,568 feet, and in a peak, on the Tírhi road, east of Masúri, to 8,565 feet. This band or outer range has a general direction parallel to the plains, and is pierced by the greater rivers, such as the Tons, Jumna, Ganges, Rámganga (western), Kosi, and Káli. Between it and the ridges descending immediately from the snowy range we cross a number of subordinate ranges which are, as a rule, of considerably less elevation than the outer range. Between China and Dhákuri Bináyak, on the road to the Pindari glacier, a distance of forty-five miles as the crow flies, there is no peak having an elevation of 8,000 feet, and very few attaining to 7,000 feet. But further westward, in the same parallel, we have groups of peaks attaining an elevation of over 10,000 feet, notably those connected with the Dudu-ka-toli range in Garhwál. When the river valleys close to the snowy range are reached, the increase in elevation is rapid and marked. The flanking ranges seldom fall below 10,000 feet, and are crowned with peaks rising still higher, until the culminating ridge crowned with perpetual snow is met.

Mountain system.

Jumna system.

If we carefully examine the great sea of mountains lying between the outer Himálaya and the snows, we shall find that the dominating ranges are spurs from the great groups of peaks, remarkable alike for their elevation and the position they fill as the boundaries of the several river-basins. On the west, the western boundary of the Jumna system is found in the elevated ridge that has its origin in the group of peaks crossed by the Shatúl and Burenda passes. This ridge follows the left bank of the Satlaj in a south-westerly direction to Hatu (10,700 feet), where it bifurcates: one branch continuing the normal direction to Biláspur, and the second proceeding in a south-easterly direction by Chor (12,081 feet), where it forms the water-parting between the Giri and the Pábar branch of the Tons. A second great ridge, descending from the Jamnotri groups, and marked by the Deoban (9,347 feet), Chakráta (7,300 feet), Chilmeri (7,160 feet), and Bairát (7,423 feet) peaks in British territory, separates the affluents of the Tons from those of the Jumna. The eastern boundary of the Jumna system is formed by a great ridge having its origin in the same group of peaks, and which joins the outer

Himálaya near the Sarkanda peak to the east of Masúri (Mussooree). The eastern boundary of the Ganges system is found in the great ridge descending in a south-westerly direction from the Nandakot peak, and which passes along the left bank of the Pindar to its junction with the Alaknanda, and thence along the left bank of the Alaknanda to Deoprayág. It admits of two great bifurcations: one at the head of the Katyúr valley and one at the head of the Lohba valley. From the group of peaks at the head of the Katyur valley a branch passes in a south-easterly direction through Binsar and Dol and along the right bank of the Ladhiya to Barmdeo on the Sárda, and from the head of the Lohba valley a branch runs south-by-east to Gujargarh, whence it passes almost due west to the Ganges at Kharak and Chándi. The tract to the south of these two arms is in shape a great obtuse-angled triangle, with its base towards the plains and its apex in the group of hills to the north of Dwára Hát. It forms the mountain basin of the western Rámganga. The eastern boundary of this system forms the western boundary of the Káli system, of which the eastern boundary is found in a great ridge descending from the Api peak in Doti of Nepál. It is clear from the above brief description that it is the spurs from the snowy range that bound the river basins, and if we examine further the affluents of each system, we shall see that the ramifications from these spurs form the water-parting between each minor system.

Ganges system.

Káli.

The principal affluents of the Jumna system are the Tons and the Giri. The Pábar, Rúpin, and Súpin unite to form the Tons, and are separated from each other by transverse ridges descending from the great boundary ridge. United they drain a delta-shaped basin having its apex at Kálsi. To the south-west the Giri drains a similarly shaped basin having its apex near Kálsi, and to the east the Jumna drains one having its apex at Kálsi. We find that the point of junction of the apices of these three deltaic basins lies within the Siwáliks, the outer range of geographers, and that the union of these three main affluents forms the Jumna of the plains. This basin, as well as the minor systems within it, is bounded by spurs from the great snowy range or transverse ridges descending from them. If we

Subordinate boundaries.

further examine the relations of the minor feeders of the three great constituents of the Jumna system, we see that, as a rule, they flow at right angles to their recipients, and that the affluents of these minor feeders obey a similar law. The ridge separating the Tons from the Jumna gives off feeders on the west to the Tons and on the east to the Jumna, at right angles to its direction. From the western slope the Dháragád, Binol, Shaula, and Manjgaon streams flow to the Tons, and from the eastern slope the Ralena, Kútni, and Silo seek the Jumna. Each of these minor feeders is separated from the other by lateral spurs, descending usually from some peak or knot of peaks, and all, as the veins on a leaf seek the midrib, flow towards the mid-depression and give it their moisture. The two great rivers that unite to form the Ganges are themselves the centres of subordinate systems. The Bhágirathi is divided from the Bhilang by a great ridge descending from the Gangotri group of peaks, whilst a second ridge having a similar origin separates the Bhilang from the Mandákini, an early affluent of the Alaknanda. The Bhágirathi unites with the Bhilang near Tírhi, and the two rivers drain a delta-shaped tract having its apex at Deoprayág. The Sáraswati and Dhauli, which form the head-waters of the Alaknanda, are separated from each other by a ridge of snowy peaks, and its more southern affluents, the Nandákini and the Pindar, are divided from each other by a great ridge descending from Trisúl. The entire basin of the Alaknanda to its junction with the Bhágirathi at Deoprayág is thus a great delta-shaped tract, cut up by the minor feeders into subordinate systems that are bounded by great ridges descending from the snowy range. Between Deoprayág and Hardwár, the Ganges receives from the east the Nayár and the Hinnal, and from the west the Súswa that drains the Dehra Dún. All unite within the Siwáliks to form the Ganges of the plains.

The Nayár.

We shall now take up the compact system of the Nayár in southern Garhwál, which at first sight would appear to be an exception to the general rules. We find that the boundary ridge that marks its exent is a continuation of the great ridge that, descending from the snowy peak of Nandakot, runs along the left bank of the Pindar to the head of the Lohba valley. Here, as already noticed, this ridge bifurcates; one branch proceeding in the normal direction along the left bank of the Alaknanda to Deoprayág, whilst the second branch passes south to Gujargarh and then west to the Ganges at Kharak. These two branches mark the axis of highest elevation in the tract through which they pass. Following the western branch, we have the Dubri peak, 9,862 feet; Dobri peak, 9,862 feet; Gandkhola, 7,553 feet; Devidatta, 7,034 feet; Kankwala, 6,651 feet; Gurdari, 5,893 feet; Jhangarh, 5,878 feet; and a peak about two miles from Deoprayág, 5,030 feet. Following the southern branch through Gujargarh, we find the second, Duda-ka-toli peak with an elevation of 10,180 feet above the level of the sea; Barmadúngi, 9,190 feet; Nandatopa, 8,086 feet; Khamek, 7,152 feet; Gujargarh, 7,969 feet; Khatti, 8,270 feet; Utain, 6,901 feet; Bukrari, 6,267 feet; and Naugarh, about a mile above Kharak, 6,065 feet. Close to the point of bifurcation, the boundary ridge sends a lateral spur southwards, that divides the basin of the Nayár into two parts, that drained by the western Nayár or Chhiphalghát river, and that drained by the eastern Nayár or Kainyúr stream. This great spur preserves the superior elevation of the boundary ridge, and is marked by the following peaks :—Barári, 8,499 feet; Bandani, 8,278 feet; Panjing, 8,810 feet; Devitank, 8,849 feet; Matikhál, 7,688 feet; and Chhatargah, 6,790 feet, when it is lost in the valley of the eastern Nayár near Kandui. Short ramifications from this spur or the boundary ridge itself determine the course of the minor feeders of the two great channels of the Nayár system. Thus a transverse ridge from Dubri, marked by the Tára-ka-kand (9,000 feet) and Banjkot (8,203 feet) peaks, divides the Chhiphalghát river near its source from its feeder at Paitháni on the left bank, whilst other ridges from Gandkhola, Devidatta, and other peaks, separate the other feeders the one from the other. A similar rule obtains along the course of the eastern branch, and we thus see that there is no real difference in principle between the arrangement of the drainage system of this apparently abnormal minor basin and that of the other greater systems already noticed.

Western Rámganga.

In the system of the western Rámganga, however, we have an arrangement for which we find an analogue in that of the Bágmati in Nepál. As we have already seen, the basin of the Rámganga is in shape a great

Káli.

obtuse-angled triangle, with its apex towards the snowy range and its base towards the plains, thus filling up the gap between those systems that have their apices towards the plains and their bases towards the snowy range. Of its affluents, the Kosi alone has a considerable course within the hills, the remainder having their origin in or close above the elevated tract lying along the foot of the hills, and joining the Rámganga at some distance southwards in the plains. Here, although the main boundary ridges are still the spurs descending from the snowy range, the several streams do not unite within the outer range, but like the Bágmati and its affluents, well beyond it in the plains. The Káli is known as the Yánkti near its source, as the Káli during the greater portion of its course through the hills, as the Chauka or Sárda in the Bhábar and Tarái, and as the Sarju and Ghogra in Oudh to its junction with the Ganges, to the south of the Gházipur district. The Káli basin is bounded on the west by that of the Ganges, and on the south-west by that of the western Rámganga. It receives from the west the Gori, Sarju, and Ladhiya, and from the east some small streams from Nepál, all of which unite within the hills to form the Sárda at Barmdeo. The Sarju is divided from its affluents, the eastern Rámganga, by a great meridional ridge, extending from their sources to their junction, whilst a second ridge, running in a south-easterly direction from the same group of peaks to Askot, separates the latter river from the Gori. The great Pancha-chuli range, running south-east from the line of water-parting, divides the basin of the Gori from that of the Dárma Yánkti, and a similar snowy range having a like origin separates the Dárma Yánkti from the Kuthi Yánkti. The great mass of peaks comprising Trisúl, Nanda Devi, and Nanda-kot thus send forth great boundary ridges from their entire southern face to the west between the Rámganga and Nandákini: to the south-west between the Nandákini and the Pindar; and between the Pindar and the Sarju; to the south between the Sarju and the eastern Rámganga; and to the south-east between the last river and the Gori. These indications are sufficient to mark the salient features of this portion of the Himálaya, and we reserve the details for the Gazetteer articles of this notice.

The snowy range.

The mountain system lying between the snowy range and the plains may therefore be said to consist of an outer range parallel to the snowy range and connected with it at wide intervals where it meets the great ridges descending therefrom. These latter bound the river basins, and the ramifications from them determine the course of the minor feeders of each system. We have now to consider the snowy range itself, and in these provinces at least it is a well-marked feature, lying from ten to twenty miles to the south of the Indian water-parting. The line of snowy peaks seen from Naini Tál and Masúri all lie to the south of the passes by which travellers cross into Tibet. The route by Nilang in foreign Garhwál through the Jádh valley crosses north of the Jamnotri group; that by Mána in British Garhwál lies to the north of the Kedárnáth group; that by Milam in Kumaon behind the Nanda Devi group; and that by the Lanpiya-dhúra, also in Kumaon, behind the Panchachúli group. The Jádh Ganga runs in a valley parallel to the snowy range and the line of water-parting, at an elevation of 15,000 feet above the level of the sea, near its source at Sumla, but gradually falling to below 9,000 feet at its junction with the Bhágirathi, near Bhaironghati. The horizontal distance between these two points is a little over 17 miles, and the fall is therefore over 350 feet in a mile. The Vishnuganga or Sáraswati descends from the Mana Pass at 18,000 feet above the level of the sea to Vishnuprayág, a distance of some 35 miles, where it is little over 5,000 feet. Here we have an average fall of about 370 feet in the mile. The increase in elevation from the place where the river valleys enter the area of greatest elevation is equally marked in the valleys of the Dhauli, the Gori, and the Dárma river. Dhárchúla on the Káli, before the line of snowy peaks is reached, is only 2,750 feet above the level of the sea; whilst Golam La, to the north and above that line, and about 1,500 to 2,000 feet above the bed of the Káli, is 8,000 feet above the level of the sea. The bed of the Káli at Changru is 10,000 feet, and in the twenty-five miles between it and the Lanpiya-dhúra Pass the fall is over 8,000 feet, giving an average fall of 400 feet to the mile. These facts well illustrate the law that the river beds[1] to within a distance of ten miles in a direct line from the snowy peaks seldom exhibit a rise of more than four or five thousand feet; but when we cross the line on which the great peaks are situated, the ascent very rapidly increases, and a very few miles carries the river-bed up to an altitude of nine or ten thousand feet, thus showing that the sudden increase of height of the mountains along this line is not confined to the peaks alone, but is a general elevation of the whole surface.

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[1] See page 8.

Axis of highest elevation.

This sudden and steady rise in elevation when the line of snowy speaks is reached appears to be a well-marked feature of the entire Himálayan range. The snowy peaks, however, do not occur in a continuous ridge, but in masses separated the one from the other by deep depressions that form the line of drainage for all the surplus moisture of the tract between the snowy range and the line of water-parting to the north. These depressions are, so far as we know, a more distinctive feature of the Indian than of the Turkish slope of the Himálaya-Tibetan mass, a fact doubtless due to the greater rainfall received by the former. The influence of the monsoon on the southern slope is shown in its supporting a more dense and varied vegetation, and even on individual ranges and hills the southern exposure is similarly strongly marked in Kumaon. It is the ceaseless action of water that has furrowed out these valleys from the great mass, and naturally this has been accomplished on a greater scale and with more results along the southern slope that receives the full force of the periodical rains. The mass of peaks known as the Gangotri, Kedárnáth, and Badrináth groups, are separated from the next group to the east by the valley of the Sáraswati, and this group again from the Nanda Devi mass by the Dhauli river. The last is again divided from the Panchachúli group by the valley of the Gori, and the latter from the succeeding group by the Dárma valley. All these valleys are inhabited and cultivated during the summer and rains, and some of them are comparatively of considerable extent. The masses of snowy peaks are more like the terminal ends of huge spurs descending from the line of water-parting than a continuous ridge. They, however, occur in regular sequence along the entire line of the Himálaya, and, as seen from the plains, have the appearance of a connected chain. The following table, showing the principal peaks that occur throughout some eleven degrees of longitude, will give some idea of their number and importance.

Points on the Himálaya mountains arranged in order of longitude by Mr. Trelawny Saunders, from the records of the G. T. S.

Number.	Name of peak.	Latitude.			Longitude.			Altitude.
I	Chumalari	27°	49′	37″	89°	18′	13″	23,944
II.	Gipmochi	27	16	23	88	56	37	14,518
III.	Paukanri (Donkia)... .	27	56	52	88	53	5	23,186
IV.	Chumunko (Chola)... ...	27	27	28	88	49	38	17,325
V.	Black rock (Gnaream) ..	27	31	7	88	48	39	17,572
VI.	Narsing...	27	30	36	88	19	28	19,146
VII.	Pandim	27	34	34	88	15	35	22,017
VIII.	Kanchanjinga	27	44	26	88	11	50	27,815
IX.	,, ...	27	42	5	88	11	26	28,156
X.	Kabru ...	27	36	26	88	9	15	24,015
XI.	Jannu	27	40	52	88	5	13	25,304
XII.	,, ...	27	39	55	87	7	56	...
XIII.	Sibsur	27	53	18	87	7	51	27,799
XIV.	Chamlang E.	27	46	27	87	1	21	21,020
XV.	Mount Everest ...	27	59	12	86	58	6	29,002
XVI.	Chamlang W. . ..	27	45	16	86	51	56	22,215
XVII.	Sankosi	27	45	11	86	36	57	22,826
XVIII.	,, .. .	27	52	16	86	31	57	21,987
XIX.	,, ...	27	48	13	86	28	32	23,570
XX.	,, ...	27	57	18	86	22	12	23,447
XXI.	,, ...	27	57	21	86	9	8	19,560
XXII.	Jabjil iya	28	7	36	85	51	42	21,853
XXIII.	,, . ..	28	21	3	85	49	21	26,305
XXIV.	,, ...	28	10	20	85	48	17	22,891
XXV.	Dayabang ..	28	15	17	85	33	35	23,76[illegible]
XXVI.	Akn .. .	28	23	25	85	10	12	21,31[illegible]
XXVII.	,, .	28	20	38	85	7	21	23,343
XXVIII.	Yassa	28	25	58	84	11	0	25,818
XXIX.	,, ...	28	30	7	84	36	34	25,729
XXX.	,, ...	28	32	55	84	36	9	26,680
XXXI.	,, ...	28	39	39	84	21	56	...
XXXII.	,, ...	28	39	21	84	20	32	...
XXXIII.	Barathor	28	29	18	84	13	56	22,917
XXXIV.	,, ...	28	32	0	84	9	52	26,069
XXXV.	,, ...	28	32	6	84	7	32	21,718
XXXVI.	Morshiadi	28	34	58	84	1	57	24,780
XXXVII.	,, ...	28	29	37	83	59	22	22,961
XXXVIII.	,, ...	28	29	48	83	59	20	22,986
XXXIX.	,, ...	28	35	38	83	51	16	26,522
XL.	,, ...	28	30	59	83	50	55	23,611
XLI.	,, ...	28	39	11	83	46	22	22,171
XLII.	Dhaulagiri	28	41	43	83	32	9	26,826
XLIII.	Káráyani	28	45	39	83	25	52	25,456
XLIV.	,, ...	28	45	8	83	25	12	25,299
XLV.	,, ...	28	43	56	83	21	18	21,912
XLVI.	,, ...	28	44	2	83	21	20	25,095
XLVII.	,, ...	28	40	21	83	19	6	23,565
XLVIII.	,, ...	28	43	49	83	15	9	21,181
XLIX.	,, ...	28	44	47	83	11	18	23,779
L.	,, ...	28	44	30	83	9	29	21,727
LI.	,, ...	28	45	53	83	8	27	21,472
LII.	Chaubisi	28	49	33	82	39	33	19,415
LIII.	Api	29	59	7	80	56	22	...
LIV.	Palchachúli	30	12	51	80	28	9	22,673
LV.	,, ...	30	15	12	80	25	5	21,171

Points on the Himálaya mountains arranged in order of longitude by Mr. Trelawny Saunders from the records of the G. T. S.—(concluded.)

Number.	Name of peak.	Latitude.	Longitude.	Altitude.
LVI.	Nandakot	30° 16′ 51″	80° 6′ 39″	22,538
LVII.	Nanda Devi	30 21 58	80 2 21	24,417
LVIII.	Nanda Devi	30 22 31	80 0 50	25,661
LIX.	Do.	30 22 35	80 0 46	25,587
LX.	East Trisúl	30 16 14	79 54 51	22,342
LXI.	Do.	30 30 56	79 54 31	23,092
LXII.	West Trisúl	30 18 43	79 49 7	23,382
LXIII	Nandákna	30 22 9	79 45 40	19,916
LXIV.	Do.	30 20 56	79 45 36	20,722
LXV.	Do.	30 20 57	79 45 35	20,773
LXVI.	Do.	30 41 6	79 44 53	22,093
LXVII.	Kamet (Ibu Gamin)	30 55 13	79 38 4	25,373
LXVIII.	Nilkánta	30 43 52	79 26 56	21,661
LXIX.	Badrináth	30 44 16	79 19 20	23,210
LXX.	Do.	30 43 22	79 17 52	22,511
LXXI	Do	30 46 41	79 16 58	22,347
LXXII.	Kedárnáth	30 47 53	79 6 34	22,790
LXXIII.	Tharlaságar	30 51 40	79 2 14	22,582
LXXIV.	Do.	30 51 41	79 2 13	22,628
LXXV.	Jaonli	30 51 18	78 53 53	21,672
LXXVI.	Ras or Srikánta	30 57 25	78 50 50	20,149
LXXVII.	Bandarpouchh	31 0 12	78 35 45	20,758
LXXVIII.	Jamnotri	31 0 25	78 34 6	20,038
LXXIX.	Swargaruini	31 0 8	78 32 32	20,405

Tibetan plateau.

After crossing the line of water-parting which, as we have seen, lies at the valley heads to the north of the line of snowy peaks, we come upon the great Tibetan plateau which has a mean elevation of from 13,000 to 17,000 feet above the level of the sea. Puling on the plateau by the Nilang route is 13,800 feet, Chiurkung on the Mána route to Totling is 15,700 feet, Chitung-dhár on the Unta Dhúra route to the Satlaj is 15,810 feet, and Buljuing near the head-waters of the Karnáli is 15,850 feet. Rabgyaling is 14,000; Gartokh, 14,240 feet; Tirthapuri, 14,820 feet; and lake Rákas Tál over 15,000 feet above the level of the sea. Captain H. Strachey has described[1] the Tibetan tableland lying between the Indian and Turkish water-partings "as the flat top of a great embankment exhibited in all its thickness in the scarp of the Indian Himálaya: the summit, though deeply corrugated with valleys and mountains in detail, being in its general relief laid out horizontally at a height little inferior to that of its southern scarp." Although the highest summits yet known and measured lie along the Indian slope, very lofty peaks have been seen in all parts of the interior, "and the passes which must be crossed to get from one Tibetan valley to another, even in the very central axis of drainage, generally equal those by which Tibet is reached from India:" so that, on the whole, Captain Strachey was of opinion that the medial depression is but faintly marked in the beds of the great rivers without much affecting the mean elevation of the mass. His description of the mountain system of that portion of Tibet lying to the north and west of Kumaon is the best that we possess, and will usefully conclude our brief review of the features of this portion of the Himálaya-Tibetan mass. "The mountains that compose the bulk of West Nári are not easily understood or defined. On ascending the highest passes we can seldom see anything but a contracted view of mountain tops on all sides, looking very like chaos: no general view of ranges under our feet is ever obtainable as the passes naturally select the ravine-heads and lowest points of the ridge which are not only flanked but often almost surrounded by the higher summits; and the valleys are commonly so steep and narrow, especially in the Rong country, that the view can hardly ever penetrate to an alluvial bottom and the sight of any inhabited place from a pass top is most unusual. When travelling along the bottoms of the valleys, we generally see nothing but a narrow tortuous passage between steep rocky walls, shutting out all extended view, and rather concealing than exhibiting the mountain ranges of which they form but the lowest outworks; consequently it is only by an extended series of observations and inferences, joined and assisted by maps, that any regular arrangement of these mountains can be distinctly established, and my account of them is liable to error in proportion to the defects of my own map. The general plan of the mountain system appears to me to consist of a series of parallel ranges running right across the breadth of the tableland in a direction so extremely oblique to the general extension of the whole as often to confound the one with the other, or to convert the transverse direction to a longitudinal one. The annexed figure may help to explain this. Short transverse necks connecting the main ranges in some parts, and cross fissures cutting through them in others, together with projecting spurs of a secondary order, will suffice to convert the supposed primary arrangements into all the existing varieties of valley and drainage.

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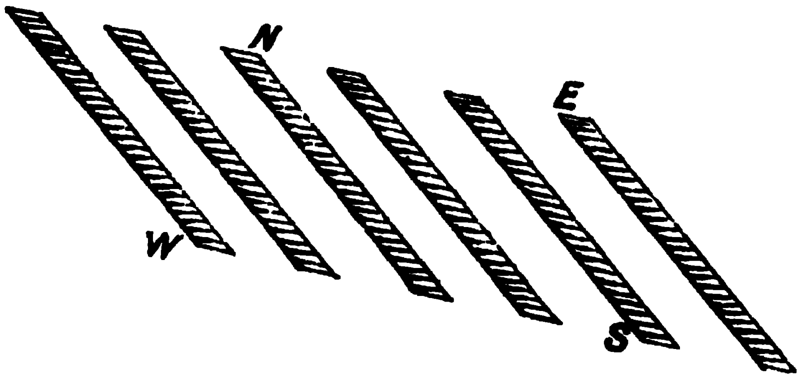
[1] On the physical geography of Western Tibet: London, 1854.



Such connecting necks, when above 18,000 feet, become more or less confounded with the main ranges, and, if not above 17,000 feet, often appear as low watersheds, just dividing the heads of two valleys lying in one line, but draining opposite ways. Secondary spurs also may be so high and so obliquely joined to the primary ranges as to make it difficult to distinguish between the two ; and the cross fissures may sometimes admit a main river to pass through a main mountain mass, in which case the continuity of the range is often evidenced by the extreme narrowness of the rocky gorge or height steepness, and geological correspondence of its sides. Much of the Indian watershed seems to be formed in this way, the great snowy peaks lying mostly on the terminal butt-ends of the primary ranges, sometimes widened by lateral spurs, and the Tibetan passes crossing the low connecting links, whose alignment forms the main watershed, but not the main mountain crest."

Glaciers.

It seems strange that so late as the year 1847 the occurrence of glaciers in the Himálaya was considered a matter of doubt by the learned in Europe. There is now no fact more widely attested and more thoroughly established than the existence of glaciers at the head of almost every valley that descends from the ranges covered with perpetual snow. In size and importance they also fitly compare with those stupendous peaks around them that have placed the Himálaya in the foremost rank of all the mountains of the earth. Colonel Gordon gives us[1] illustrations and descriptions of the great glaciers met by the Yárkand Mission on the journey between Leh and the Kárakoram pass. He mentions the lower Kumdan glacier that comes from the high peaks to the north-west, and continues down the right bank of the stream for over two miles, "forming a perfect wall of ice, rising from the water about 120 feet, and showing a surface covered with countless pinnacles and points." The Remu glacier, also seen by Colonel Gordon, rises amongst peaks and ridges from 19,000 to 24,000 feet high. "It is about 21 miles in length and from one to one and three-quarters mile broad, terminating at an elevation of 15,800 feet above the level of the sea, with a width of about three miles of gigantic cliffs of ice fully 250 feet high." He adds :—"the glaciers of the western Himálaya are twice as extensive as those of the Alps, and are probably the largest in the world, or at all events larger than any others out of the polar regions. One in the Muztágh range is believed to be 34 miles long with fifteen distinct moraines ; while in its immediate vicinity is another, 31 miles in length, which may be said to join with it in making 65 miles of continuous ice." Other glaciers have been described by travellers in the ranges between Ladák and Garhwál. In the tract with which we are more immediately concerned we have glaciers at the head of the Jádh Ganga, the Bhágirathi, Vishnu Ganga, Dhauli, Kailganga, Sundardhúnga, Pindar, Kuphini, eastern Rám-ganga, Gori, and Dárma Yánkti. Lieutenant Weller[1] in his visit to the source of the Gori near Milam, describes that river as coming "out in a small but impetuous stream at the foot of apparently a mass of dirt and gravel some 300 feet high, shaped like a halfmoon. This is in reality a mass of dark-coloured (bottle-green) ice, extending westward to a great distance, and covered with stones and fragments of rock which in fact form a succession of small hills." Here and there were circular and irregularly shaped craters (as it were) from 50 to 500 feet in diameter at top, and some of them 150 feet deep, and higher up these gave place to narrow fissures. This glacier is between seven and eight miles long, and terminates at an elevation of 11,600 feet above the sea. The glacier of the Pindar in Kumaon is the one, however, regarding which we have the most complete informatiom, and we shall confine ourselves, therefore, to its description in detail.

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[1] Roof of the World, 17.

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[1] J., A. S., Ben, XI., 1166.

Glacier of the Pindar.

The Pindar river[1] is an affluent of the Alaknanda, and has its rise in a glacier to the west of the Nandakot peak and its valley, where the glacier ends, is about a mile across between the precipitous mountains that bound it. From the foot of the rocks on either side the bottom of the valley slopes inwards with a moderate inclination, leaving in the middle a hollow about 300 yards wide and 250 feet deep, with very steep banks, at the bottom of which flows the river. This comparatively level space between the precipices on either side and the river bed is observable for a mile or more below the end of the glacier, though much cut up by watercourses. The glacier occupies about two-thirds of the whole breadth of the head of this valley, leaving between itself and the cliffs on the east an open grassy slope, which extends along the foot of the moraine for upwards of a mile and a half above the source of the river, and which seems to be a continuation of the level space before mentioned. The first appearance of the glacier is thus described :—"It seems to be a vast rounded mass of rocks and ground utterly devoid of any sign of vegetation, standing up out of a grassy valley. From the foot of its nearer extremity the river, even here unfordable, rushes in a turbid torrent out of a sort of cave ; the top of which is but a few feet above the surface of the water (May). The end, immediately over the source of the river, is very steep and of a dull black colour. It is considerably fissured, the rents appearing to arise from the lower parts, tearing themselves from the upper by their own weight. On a closer examination this abrupt end proves to be a surface of ice covered with sand and gravel and curiously striped by the channel made by the water that runs down it as it melts. Behind this, the glacier rises less steeply, like a bare gravel hill, to its full height, which is probably about 500 feet above the water of the river when it leaves the cave. In some places, however, are seen great fissures both vertical and horizontal, the latter evidently made by the separation of regularly stratified layers."

Feeders of the glacier.

The glacier is formed by the meeting of two ice streams from gorges, one coming from the north-west and the other nearly from the east, and which

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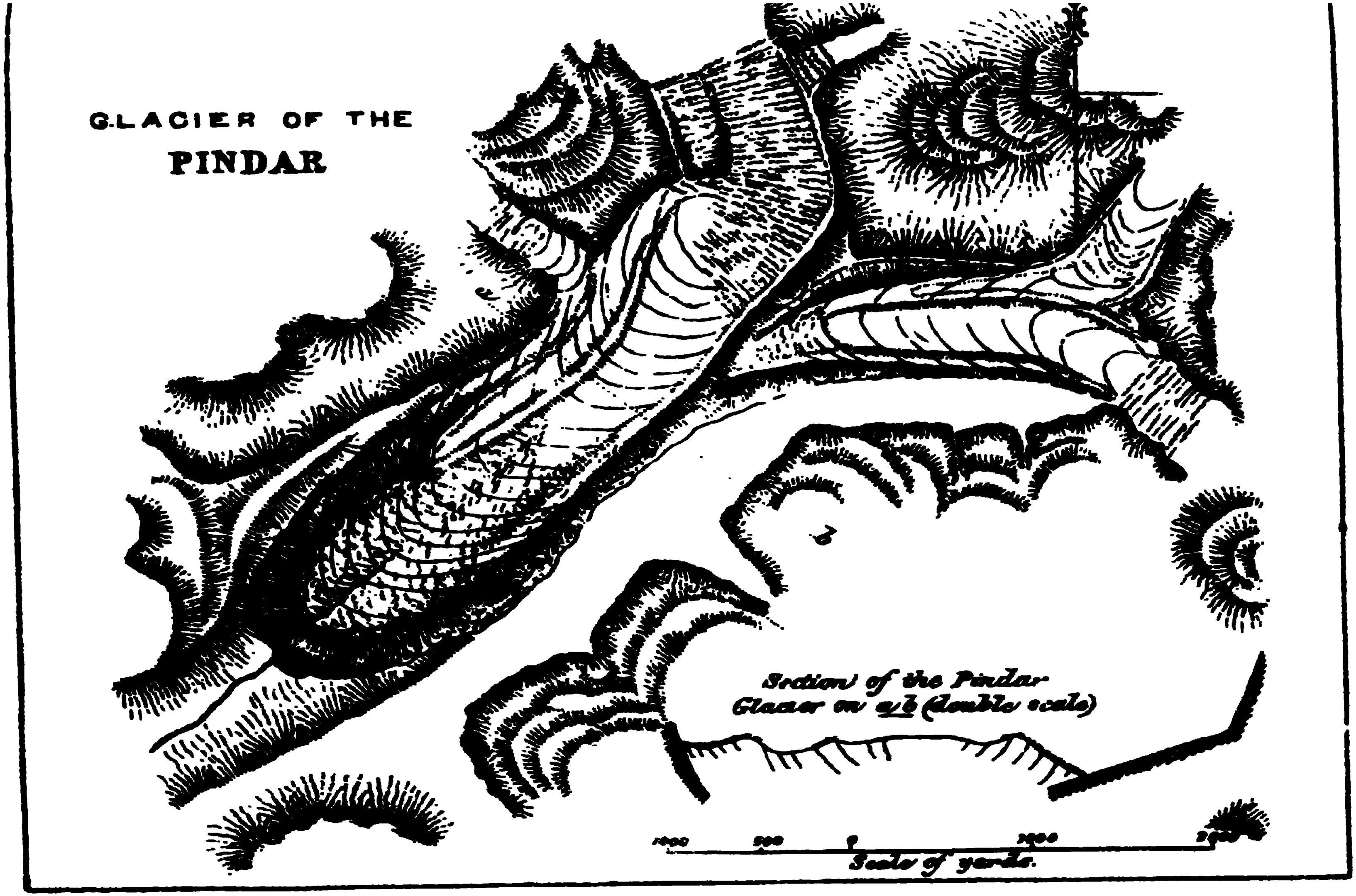
[1] From "A description of the glaciers of the Pindar and Kuphini rivers in the Kumaon Himálaya," by Lieutenant R. Strachey, Ben. Eng., J., A. S B., XVI., 794, and "Note on the motion of the glacier of the Pindar in Kumaon" by the same. *Ibid.*, XVII., ii., 203, and given as nearly as possible in the writer's words as the only scientific examination of these glaciers that we possess.


GLACIER OF THE
PINDAR

J. A. S. Beng. XVI. 736.

meet about two miles above the source of the river, as shown in the accompanying sketch.

The feeder from the north-west is larger than that from the east, and its surface is at a considerably higher level for some hundred yards below their first junction. It descends with a great inclination, entirely filling the gorge, down which it comes in a cascade of ice. It assumes the general appearance of a confused mass of irregular steps, which are again broken up transversely into peaks of every shape. The west side of this cascade continues nearly in its original direction after having passed the point below which the glacier bends sharply to the south-west, and in this way completely crosses the glacier. The steps in which it falls, however, also gradually change their direction so as to remain nearly perpendicular to the general current of ice. The transition to the regular level ice is very sudden, and begins much higher up on the west than on the east side. Near the foot of this ice-fall the steps were observed to have their tops considerably overhanging. A small tributary, also descending in cliffs of ice, joins the main glacier from a ravine on the east, not far above where it takes the sudden bend. The feeder from the east is formed by the union of two smaller glaciers, one from the north-east and the other from the south-east, which is the larger of the two. The north-eastern tributary appeared to have no very steep inclination, but was considerably broken up at its junction with the other. Another small glacier joins the main one from the north-west, a short distance below the point where it bends southwards. Its inclination is very great, but it perfectly maintains its continuity of structure to the bottom.

Moraines.

The lateral moraine of the west side of the northern branch of the glacier is first seen near the bend, where it shows itself as a black band along the edge of the ice which in other parts of the fall is quite white. The moraine is small between the bend and the tributary glacier below it, but very rapidly increases, and in its lower parts is a chaos of desolation. This great addition to the size of the moraine is owing to the quantity of *débris* brought down by the small glacier. The ice below the junction is much broken up by crevasses, and rocks and gravel from the moraines on both sides of the tributary glacier are scattered over the space between them, and the moraines at first sight seem to lose their distinct form. Although there is no clear ice between the moraine that originates on the east of the tributary and the west side of the glacier, the identity of that moraine is sufficiently marked by its colour and by the regular rise above the general surface of the glacier of its top, which remains tolerably even for some way down, being beyond the limit of the disturbance caused by the crevasses along the edge of the glacier. About half way down to the lower end of the glacier, however, the full action of these crevasses reaches the whole of the moraine, and it is scattered or lost sight of in the general confusion of surface. An epoch of peculiar destructiveness to the mountains is marked in one part of this moraine by the accumulation of huge masses of rock from 20 to 30 feet square and as much as 15 feet high, and the stone found on it are generally larger than those on any of the other moraines. The true west lateral moraine, below the tributary glacier, is not very large, nor is its top much elevated above the bottom of the valley, excepting quite at its end.

The lateral moraine of the south-eastern side of the glacier is very large. Its top rises, on an average, probably 250 feet above the bottom of the valley. Along its foot runs a stream, gradually increasing in size, that collects the open drainage of the outer slopes of the moraine. The lower part of this slope is a mass of loose stones and earthy gravel which rolls down from above, as the face of the ice which is visible in the upper fifty or sixty feet of the slope melts and recedes, a process that is constantly going on. On the inner side the slope of the moraine is thirty or forty feet above the level of the clear ice of the glacier. The upper part of the moraine comes down nearly straight from the point where it meets the foot of the north moraine of the east glacier. The north branch glacier being considerably higher than the eastern, the moraine slopes down from the bed of the former to that of the latter, forming a deep angular depression where they meet, that gradually diminishes in depth up to the top of this glacier, which is here entirely covered with *débris*, the moraines of its two sides being scattered all over it for some distance above its union with the north or main branch. The resulting appearance is that the northern branch runs over the eastern, or that the latter runs into the former and is absorbed by it. The eastern tributary brings

From a photograph by Sachse

[illegible] of the [illegible] Glacier

down moraines that spread over the whole of its breadth at its extremity. Besides these lateral moraines there is a medial one that is first seen as a dirty stripe along the ice cliffs of the fall at the head of the north glacier. As it comes down the level ice it gradually begins to assume the decided appearance of a moraine, and increasing by degrees at last becomes very large. It continues in a well-defined form for some short distance beyond where the western moraine is dispersed, but there it also is scattered over the ice, and the two become blended together, and ultimately extend to meet the *débris*, which is similarly dispersed by the eastern moraine from the opposite site of the glacier. The whole of the moraines, in the middle of the length of the glacier where it is most regular, are very considerably raised above the general surface of the ice, which in some parts may be as much as one hundred feet below the tops of the western and medial moraines. It would appear that this great elevation is not so much due to the accumulation of *débris* as to the protection afforded by the superincumbent rubbish to the ice below which prevents its being melted. The clear ice beyond the moraine is constantly depressed where exposed, and on the very tops of the moraines pure ice was often seen hardly covered by stones. The protection afforded by the lateral moraines raises the sides of the glacier so much that a very considerable hollow is caused in its middle, which is a striking feature in the first appearance of its lower extremity.

Crevasses ; glacier tables.

The ice of which the glacier is composed is perfectly pure and clear, but where seen in considerable masses, stripes of a darker and lighter bluish green are distinctly visible. It is composed of bands of ice containing small air bubbles, alternating with others quite free from them. In many places the surface presents a striated appearance, arising from the different degrees of compactness of these differently coloured bands and their consequently different rates of melting. The direction of these coloured views as seen in crevasses showed a dip inwards or towards the longitudinal axis and a dip upwards or towards the origin of the glacier in every part, the stratification being more perpendicular towards the head and more nearly horizontal in the lower parts. The direction of the strata in place was also very clearly marked in many parts of the ice, and was placed in curves, having their branches nearly parallel to the sides of the glacier and their apices directed downwards, the curvature in the centre not being at all sudden. No dirt bands were observed. The crevasses were neither very numerous nor very formidable. They are developed across the direction of the glacier's length on both of its sides, commencing from the small tributary on the west side and from the union of the eastern glacier on the other, and continuing almost to the end, those on the west side being, perhaps, the larger. They are generally wider towards the edges of the glacier, closing up as they approach the centre. They are nearly vertical, and are directed from the sides upwards or towards the head of the glacier, those on the west bearing nearly east and west, and those on the east bearing nearly north and south, thus forming angles of about 45° with the axis of the glacier. Many pools of water (*baignoirs*) were seen on the surface of the ice; some of the largest were said by the guides, who are in the habit of visiting the glacier, to be found in the same place every year. The clear surface of the ice everywhere assumes a more or less undulating appearance from the action of the water that drains from it as it melts and the small streams, into which the drainage collects, end by falling into some of the crevasses. The remains of the last winter's snow was hardly perceptible on any part of the glacier. The occurrence of stones standing up on bases of ice (glacier tables) above the general surface of the glacier is common, but those seen were small. The rocks below the bend in the north-western glacier were covered with grooves or scratches, sloping in about the same direction as the surface of the ice at the spot. These grooves extend to twenty or thirty feet above the present level of the glacier. Almost in every place a space was left between the rock and ice, the latter appearing to shrink from contact with the former, due doubtless to the heat of the rock melting the ice.

Glacier of the Kuphini.

The Kuphini river, that rises on the side of the Nanda-kot peak, opposite to the Pindar river, has also its source in a glacier. Both rivers unite at Dwáli, about eight miles from the end of the Pindar glacier and about six miles from the end of that of the Kuphini. General Strachey examined the Kuphini glacier also, and describes the valley for a mile or two below the end of the glacier as having very much the same general character as that of the Pindar, but somewhat more rugged and desolate in appearance. The glacier commences about two miles above the source of the river and fills the whole breadth of the valley, which is about three-quarters of a mile broad in its upper part. The glacier begins in a precipitous fall of ice some sixty or seventy feet high, which, however, still exhibits the ribbon-like structure. From the foot of the fall the surface was very even, though the slope was still considerable. The main glacier of the Kuphini is joined by two small tributaries on the east and by one on the west, all of which are highly inclined and bring down considerable quantities of *débris*. The moraines are confined to the sides of the glacier, though many small stones are scattered over every part of the ice. As was observed on the Pindar, the protection given by the lateral moraines to the underlying ice leads to the promotion of a medial depression in the glacier at its end. The crevasses here, too, are most strongly marked near the sides and are inclined at an angle of about 45° from the longitudinal axis downwards. The structure of the ice was in all respects similar to that found on the Pindar. On the interesting question of the extension of glaciers at a remote period the inquiries of General Strachey give no precise information. He, however, considers that "some very decided change in the state of things is certainly indicated by the long plateaus before mentioned running for a mile or two below the present terminations of both glaciers nearly parallel to the rivers, but several hundred feet above them." He considers it "impossible that these level banks above the rivers have been caused by deposits from the ravines in the sides of the valleys, for such deposits would have had very irregular surfaces, and indeed their present effect in destroying the regularity of the plateaus is everywhere visible. Had the same appearance been noticed in any other part of the river's course, it would at once have been attributed to the action of water at some former period, and it would have been supposed that the bed had afterwards been excavated to its present depth. If this was the case, the glaciers which the plateau was forming must either have terminated considerably higher up the valleys or have stood altogether at a much higher level. In either of these ways the water could have been delivered at a level sufficiently high to form the plateau. But it may admit of doubt whether the quantity of water in the rivers, as they are at present, is sufficient to account for such an extent of level deposit or for such a depth of erosion of their beds; for at this great elevation they are not subject to those violent floods that occur lower down, and for nearly half the year too they are inert. The only other way of accounting for the appearance is that it has been occasioned by an extension of the glacier, and that the level top of the plateau shows the limit to which the tops of the moraines reached, as the glacier gradually receded." We have referred on a previous page[1] to the existence of evidence of glacial action far below the present limits of glaciers, and to those who wish to pursue the subject further we commend the records of the Geological Survey and the summary[2] in the recently published 'Manual of the Geology of India.'

Motion of the Pindar glacier.

General Strachey has rendered us another important service in his observations on the motion of the Pindari glacier recorded in May, 1848. His procedure is thus stated. About 200 yards below the small tributary that enters the main glacier from the north-west a moraine was found heaped up against an almost perpendicular wall of rock, and sufficiently high to command a view of the greater part of the surface of the glacier along the line on which observations were to be made. This line, which is nearly perpendicular to the general direction of the glacier, was marked by two crosses painted white, one on the rock in contact with the old moraine and one on a cliff on the opposite side of the valley. A stake was driven into the moraine at its highest point, close to the rock, on the line between the two crosses, and a theodolite was set up over it. Five other marks were also made on the glacier at intervals along the same line by fixing stakes in holes driven in the ice with a jumper. These marks, which were all carefully placed on the exact line between the crosses by means of the theodolite, were completed at about 0h. 30m. P. M. on the 21st May. On the following day the theodolite was again set up on the same place as before, and being properly adjusted, the cross-wires of the telescope were directed to the cross on the cliff on the opposite side of the glacier. A stick was then set up near the first of the five marks that had been made the previous day, and was, by means of signals, moved up or down the glacier, till it appeared to coincide exactly with the cross-wires of the telescope, and consequently to be exactly on the line between the two crosses painted on the cliffs. The distance between the centre of the stick and that of the fixed mark was then measured, which evidently showed the downward progress of the ice at that point of the glacier, since the marks were made the day before. The same procedure was followed at each of the marks. The results were as follows :—

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[1] P.

[2] Pp. lxx., 372, 373, 586, 689.

Time of observation.	*Distances of fixed marks from standard line.*				
	On the west moraine.	On the medial moraine.	At east foot of medial moraine.	Near the middle of the clear ice.	On the eastern moraine.
h. m.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
21st May 0 30 p. m.	...	...	...	...	...
22nd „ 1 15 p. m.	0 5½	1 0¼	1 0	1 0¼	0 6¾
25th „ 8 45 a. m.	1 9½	2 9¾	2 11½	3 1	1 5½

The motion in 24 hours of the several marks will also be found to be—

Date.	*Mean motion (in inches) of ice in 24 hours.*					
	On the west moraine.	On the medial moraine.	At east foot of medial moraine.	Near the middle of the clear ice.	On the east moraine.	Approximate mean temperature.
21st to 22nd May ...	5·3	11·9	11·6	11·9	6·5	43°F.
22nd „ 25th „ ...	5·7	7·6	8·4	8·8	3·8	36°F.
General mean ...	5·5	9·7	10·0	10·3	5·1	...

The progress of the lower extremity of the glacier was likewise approximately measured by observing the apparent angular motion of a pole fixed on the top of the eastern moraine, and of a conspicuous rock lying not far from the middle of the glacier. The results of these observations were—

Date.	*Mean motion (in inches) of ice in 24 hours.*	
	On the moraine.	Near middle of the glacier.
19th to 20th May	3·0	...
20th „ 23rd „	6·2	8·1
23rd „ 25th „	5·3	10·8
General mean	4·8	9·4

A comparison of the motion of the upper and lower parts of the glacier gave on the lateral moraines 4·8 inches as the mean motion of the ice in 24 hours in the lower part of the glacier, and 5·3 inches in the upper part, and in the middle of the glacier 9·4 inches as the mean motion for the lower part, and 10 inches for the upper part of the glacier. The elevation of the foot of the glacier at the source of the Pindar is 11,929 feet, and of the theodolite station, where these observations were made, was 12,946 feet above the sea.

Snow-line.

We have made mention of the snow-line or limit of perpetual snow,[1] which has, at times, given rise to considerable discussion. The height at which precipitations of vapour fall to the earth's surface as snow varies with the temperature of each particular place, and with the annual or even diurnal oscillations of the temperature. In Bhután and Sikkim the ordinary winter limit of snow is about 6,000 feet, and it is rare, says Dr. Hooker, for even three inches to remain on the ground as many days at 7,000 feet.[2] According to General Strachey, the height at which snow is certain to fall in Kumaon is about 6,500 feet, and at an elevation of 5,000 feet it will not fail more than one year out of ten. The lowest level to which sporadic falls of snow are here known to descend is about 2,500 feet, of which there are two authentic instances on record since the British occupation, the first in 1817 and the second in 1847. In the valley of Kashmír, at an elevation of 5,500 feet, the snow falls every year,[3] and further west as low as 4,000 feet, whilst at least one fall of snow is recorded at Peshawar, which has an elevation of only 1,250 feet above the level of the sea.[1] Campaigning experiences during the late war show that the winter snows descend to a very low elevation in the valley of the Kábul river and at Kandahár. If we follow the lower boundary of the winter snow on a mountain as it melts with the advance of summer, we at length ascend to a height at which the summer influence is insufficient to entirely melt the snow, and from which, as the season advances towards winter, we have gradually to descend in order to follow the line of snow. The line to which the snow recedes, and from which it again advances in one complete revolution of the seasons, is called the snow-line. The snow above that line is called perpetual snow, not as observed by Professor Forbes, that the continuance of snow at any spot implies that it never melts there, but only that some always remains unmelted.

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[1] These observations on the snow-line are based on the article in J., A. S., Ben., XVIII., i, 287, entitled, "On the snow-line in the Himálaya," by Lieutenant R. Strachey, Engineers, on notes placed at my disposal by the same writer, and on the works of recent travellers.

[2] Hooker, Quar. J., Hort. Soc., VII., 144; Griffith Post. Papers, I., 236.

[3] Moorcroft, II., 107.

Observations in the eastern Himálaya.

According to our best authorities, the height of the snow-line on the most southern exposures of the Himálayan slope that carry perpetual snow ranges from 15,000 to 16,000 feet all along that part of the chain that lies between Sikkim and the Indus, whilst to the north towards Tibet it has a considerably higher elevation. Before proceeding further we may observe, with General Strachey, that "all estimates of the snow-line are, in the very nature of things, subject to no little uncertainty; for, independently of the variations of the seasons from year to year there are naturally considerable differences in the level at which the snow lies on steep or slight slopes and on north or south exposures, between the latter of which a difference of as much as a thousand feet may at times be observed. Besides this, too, there is some practical difficulty in the actual observation of the snow-line, for the process of judging by the eye whether the snow upon one's path and still more on contiguous mountain sides begins to exceed the bare spaces is neither easy nor susceptible of much precision. Hence the errors and uncertainty to be looked for in all our conclusions must be considerable, amounting no doubt to several hundred[2] feet." Dr. Hooker estimated the height of the snow-line on the most southern spurs of the snowy mountains in Sikkim to be at about 15,500 feet.[1] Of the peaks covered by perpetual snow, the elevation of which is noted in Dr. Hooker's map, Chola, on the boundary between Sikkim and Bhután, is the lowest, (17,300 feet), and at the same time the most southern and the Chola Pass immediately to the south of the peak, and rising to 14,900 feet, he found to be free from snow at the beginning of November. Somewhat further to the north, near Younghong, the lower limit of perpetual snow was directly measured in September and found to be nearly 16,000 feet. To the west of Kanchanjinga in eastern Nepál, the south-eastern descent from the Kambacho pass was found to be free from snow, a little from the summit, at the beginning of December, and on the northern approach the snow was supposed to become perpetual at about 15,000 feet, though the fresh falls of the previous October forced Dr. Hooker to be in some measure guided by the people of the country in this estimate. On the ascent to the Wallanchun or Wallungsum pass the snow-line was again estimated, though under similar circumstances of doubt, to be at 15,000 feet. The Pandit crossing the same pass, his Tiptala, on the 16th August, 1871, found it covered with snow,[2] and Dr. Hooker on December[3] 31st, 1848, crossed "with snow on both sides up to the shoulder."

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[1] Bom. Geog. Jour., X., 39.

[2] Captain H. Strachey, J. R. G. S., XXIII. 69.

Observations in Kumaon.

The following are the results of trigonometrical measurements of the elevation of the inferior edge of the snow observed on spurs of the Trisúl and Nanda Devi groups of peaks, made by General R. Strachey before the winter snow had commenced in 1841 :—

Point observed.	*Height of snow-line.*		Mean.	Remarks.
	On south exposure.	On west exposure.		
No 1 ...	16,705	15,892	16,298	These heights were calculated from observations made with the theodolite at Almora and Binsar. The distance of these two places, which served as a base, was obtained by measurement from a map of points fixed by the G. T. Survey. The elevations of the two places were taken from Captain Webb's trigonometrical survey.
2 ...	17,007	...	...	
3 ...	17,205	14,898	16,051	
4 ...	15,347	...	...	
Mean ...	16,566	15,395	16,174 15,980	

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[1] Himálayan Journals. [2] Reports, 1871, p 1 : the name appears to be derived from the Wallungsumgola to the south : the pass itself has an elevation of 15,618 feet. [3] J., A. S., Ben., XVIII., i, 524.

The points 1, 2 and 3 are on ridges that run prominently out in a south-westerly direction from the great peaks of Trisúl G. (G. T. S.) same as Webb's No. XI. and H. (G. T. S.), same as Webb's No. XII. The dip of the strata being to the north-east, the faces exposed to view from the south are for the most part very abrupt and snow never accumulates on them to any great extent. This will explain the difference between the heights at which snow was observed on the southern and western exposures, the ground having been less steep on the latter and better able to retain the snow; but in these places it was in very small quantities, and had probably fallen lately, so that its height may probably indicate the elevation below which the light autumnal falls were incapable of lying rather than the inferior edge of the perpetual snow. It is further to be understood that below this level of 15,000 feet the mountains were absolutely free from snow, excepting those isolated patches that are to be seen in ravines or at the head of glaciers, which do not affect such calculations as these. The point No. 4 was selected as being in a much more retired position than the others, and is situated not far from the head of the Pindar river, between the peaks of Nanda Devi, I. (G. T. S.), same as No. XIV. of Webb, and of Trisúl H. (G. T. S.) It was quite free from snow at 15,300 feet. On the whole, therefore, General Strachey is inclined to consider that 16,000 feet may be given as a close approximation to the maximum height to which the snow recedes every year on the most southern and external ranges in Kumaon.

Bisahr.

This result appears to accord well with what has been observed by Dr. Gerard in a visit made by him to the Shatúl pass in the Bisahr range expressly for the purpose of determining the height of the snow-line.[1] He reached the pass, the elevation of which is 15,000 feet, on the 9th of August, 1822, and remained there till the 15th of that month. The southern slope of the range was generally free from snow, and he says that it is sometimes left without any whatever. On the top of the pass there was no snow, but on the northern slope of the mountain it lay as far down as 14,000 feet. On his arrival rain was falling, and out of the four days he was there, it rained and snowed for the greater part of three. The fresh snow that fell did not lie below 16,000 feet, and some of the more precipitous rocks remained clear even up to 17,000 feet. Dr. Gerard concludes that 15,000 feet is about the height of the snow-line on this range, but it will be seen that Dr. Gerard was there rather early in the year, and General Strachey, from what he heard from others who crossed the range later in the season, thinks that 15,500 feet will probably be a better estimate, even if it should not be carried still higher. At the beginning of the month of July, Captain Gerard found heavy snow on the northern face of this Bisahr range at about 15,000 feet, and the Kunlia pass, the elevation of which he states to be 17,000 feet appears never to be free from snow[1] Dr. Thomson[2] agrees that the estimate formerly made by General Strachey of 15,500 feet, which his subsequent researches led him to believe was a little too low for Kumaon, is as nearly as possible correct for the Bisahr range. He adds—"Captain Herbert, in his geological report, had fixed upon 15,000 feet, which is a little too low even in the district of Bisahr, to which his estimate, I believe, refers. In the trans-Satlaj Himálaya, from the diminished amount of summer cloudy weather, the snow-level is probably a little higher." The Chamba range and the Pir Panjal, south of Kashmir, both of which rise immediately from the low external sandstone hills, just enter, he tells us, the region of perpetual snow. The highest peaks of the former are about 16,700 feet, and its mean height about 15,000 feet above the sea, and its snow-line will consequently be not far from 16,000 feet. Major A. Cunningham also places the snow-line on the most southern ranges of the Himálaya to the west of the Ganges at about 16,000 feet.[3]

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[1] Tours I., 289-347.

Across the snowy range.

When, however, we advance into the interior of the chain, after having once passed over any range of sufficient height to come within the limits of perpetual snow, we invariably find that there is less snow on all such ridges of similar altitudes so that when we arrive at the Indian watershed, the snow-line has risen to about 18,500 feet, and on the summit of the tableland it reaches to an elevation of 20,000 feet. Dr. Hooker observed this phenomenon in Sikkim, and bears testimony to the gradual rise of the snow line as we enter among the peaks covered with perpetual snow. Near Zemu, twenty miles north-east from Kanchanjinga, he found little snow on south exposures at the beginning of July. A little further in, above Phalung, in the middle of the same month, the snow-line was supposed to be about 16,500 feet, and at the end of the month many plants were obtained at 17,000 feet. Another ascent in the same vicinity about the same time did not carry our traveller to perpetual snow at 16,800 feet. On the flanks of the Kanchan-jhao broad summits were seen quite bare of snow at 18,000 feet. Dr. Campbell[1] who accompanied Dr. Hooker on his return journey in September, notes that vegetation ceased at the foot of the Dankia pass at 18,000 feet, and there was no trace of it within 500 feet of the summit on either side. There was no snow on the road as he ascended the north face nor as he descended the south face, but it lay in patches amongst the rocks all the way on both sides. On the mountain to the west of the pass snow lay deep in hollow places, but these may have had glacial ice in them though the surface of the snow was then smooth. The line of snow would here be 19,800 feet, and further north in Tibet it rose to 20,000 feet. Bhorutso, on the 18th October, had not a particle of snow on it at 18 or 18,500 feet, whilst in the Lachung valley in Sikkim to the south snow was lying at about 15,000 feet. Dr. Campbell adds:—"South of the Himálaya, the quantity of snow that falls is very much greater than in Tibet, and from the greater moisture of the air and cloudiness of the sky, it is not carried off with the rapidity of evaporation which obtains in Tibet, where you do not find even a rill of water from the melting snow. Besides in Tibet the snow falls in light, feathery skiffs, and not in flakes. I believe that the lowest snow-line we saw on the mountains to the north of us in Tibet must have been upwards of 22,000 feet. On the Kambajang range, which, comparing them with Bhorutso, must be 20,000 feet at least, there was not a particle of snow."

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[1] *Ibid*, II., 71. [2] Travels, p. 487. [3] Ladák, pp. 73-77.

Kumaon.

We have the results of General Strachey's experience for Kumaon and Garhwál. Towards the end of August, 1848, he crossed the Barjikáng pass leading from Bálam to Juhár on a subordinate ridge between the Nandakot and Panchachúli peaks. Although this pass has an elevation of about 15,400 feet, not a vestige of snow was met with on the ascent from the south-east, and only a very small patch remained on the north-western face, and indeed, in no considerable quantity, up to 17,000 feet. The vegetation on the very summit of the pass was far from scanty, though it had already begun to break up into tufts, and had lost the character of continuity it had maintained to within 500 or 600 feet of the top; but many species of flowering plants, all evidently flourishing in a congenial climate, showed that the limits of vegetation and regions of perpetual snow were still far distant. This place is within ten to fifteen miles of the most southern border of perpetual snow. The Unta-dhúra pass has an elevation of about 17,300 feet, and lies to the north of the great peaks nearly at the crest of the watershed. There was no snow along the southern ascent to this pass, at the top of which General Strachey arrived in September, 1848, in a little drizzle of rain that at last turned into snow. The ground was quite free from snow, being worked up into a deep black mud by the feet of the cattle that had crossed it. There was, however, on the north side of the pass an accumulation of snow some little way down, extending perhaps 200 feet, apparently the effect of the drift through the gap in which the pass lies. No snow was seen on the hills on either side within some few hundred feet, and the snow-line was certainly above 18,000 feet. Vegetation reached to within 300 or 400 feet of the summit.

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[1] J., A. S., Ben., XXV., 565.

Garhwál.

The Chor-hoti pass (18,000 feet) and the Marshak pass, (18,400 feet), both to the north of Níti, have a position relative to the great snowy masses nearly similar to Unta-dhúra. The Marshak pass was crossed in July by General Strachey, a time rather too early to judge fairly of the snow-line, which is also obscured by the presence of a glacier that fills up the valley by which the pass is approached.[1] On the Chor-hoti pass in September there was not a vestige of snow on any part of the southern face of the ridge that the route crosses, but on the north face was a patch that was plainly perpetual, descending some hundred feet to a glacier which was connected with that just mentioned to have been crossed at Marshak or Balchak. The snow-line was, therefore, here no doubt near 18,500 feet. The Kyungar and

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[1] This expedition is apparently referred to in J., A. S., Ben., XIX., 79.

Balchha passes, each about 17,500 feet in elevation, and both lying to the north of the Unta-dhúra pass, were equally free from snow on their southern faces in September, small quantities only being found on the northern aspects. The highest points on the ridge, over which the latter of these passes leads, only just exceed 18,000 feet in elevation, and in fact it does not come within the limits of perpetual snow, nor does it appear snowy when viewed from the Tibetan plain to the north of it. The vegetation on all these passes reaches to about 17,500 feet. Lieutenant Weller visited the Balchha pass[1] on the 1st June, 1842, and found "towards the top of the ascent a tolerable quantity of snow, but in detached portions." The Lákhar pass also, to the north of Unta-dhúra, was crossed by General Strachey in September. It has an elevation of about 18,200 feet, and was found free from snow on both sides, as well as the Jainti ridge some 200 feet higher. This latter is, however, a somewhat detached spur, and the snow-line was manifestly near, for unbroken snow could be seen in more sheltered places considerably below this elevation. General Strachey thinks that, on the whole, 18,500 feet may be considered a fair average height of the snow-line in this locality. Lieutenant Weller crossed the Unta-dhúra pass at the end of May, and found more soil than snow visible, whilst snow was scattered thinly on either side, but the northern slope presented one unbroken sheet of steep snow.[2] In September (28th) Captain Manson found the last ascent to this pass quite free from snow. A detached peak, Lanjar, a little to the north of the Níti pass, and having an elevation of 18,400 feet, was found by General Strachey nearly quite free of snow having only a patch lying in a ravine on the north side of the hill. Two other peaks near the Balchha pass, seen from Lanjar, having an altitude of 18,100 and 18,200 feet respectively, were also quite free from snow, so far as could be ascertained at the distance. Mr. J. H. Batten, who visited the Níti Pass in 1837, found it free from snow, of which the first heavy fall did not occur till the 11th of October.[3]

In the more western part of the mountains the authority of the Gerards, of Dr. Thomson and of Major A. Cunningham coincide in fixing the snow-line at much about the same level as that just assigned to Kumaon. Captain J. D. Cunningham also accepts

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[1] J., A. S., Ben., XII., 97. [2] *Ibid.*, XII., 87. [3] *Ibid.*, VII., 316.

Kunaor.

the results of General Strachey's observations. In upper Kunaor Captain Gerard[1] found a little snow on either side of the Kyubrang pass (18,300 feet) in July, but none on its summit, and the summits in the neighbourhood, though attaining a height of 18,000 or 19,000 feet, were only just tipped with snow.[1] The Gangtang pass, also 18,300 feet and lying a little farther to the west, was snowy for the last few hundred feet at the end of the same month. The Kyubrang pass is on the Indian waterparting, and the Gangtang pass a little within it, but both the observations were made before the snow-line had attained its maximum elevation. The gradual descent of the snow-line as we advance southwards is shown by the fact of the Charang pass having an altitude of only 17,400 feet, and lying between the passes above named and the Bisahr range, being said to be never free from snow, though early in July it had already melted up to 16,300 feet. North of the Satlaj, under the peak Leo Porgyul, the surface was found to be free from snow in October up to 19,000 feet or even higher, while west of that river on the Manirang or Rupak pass, having an elevation of 18,600 feet, the summit was covered with newly fallen snow at the end of August, showing that the level of perpetual snow was nearly at its maximum. Snow was, however, met with on the road to the pass, but this was due to avalanches and drifts and to the fact of the road lying in a deep glen. Dr. Thomson, who visited the Kárakoram pass in August, 1848, estimated the snow-line on the journey back to Sáser at 17,500 to 18,000 feet but to the northward and eastward it was much higher, probably not less than 20,000 feet.[2] Trotter[3] also notes that the Kárakoram pass (18,550 feet) is always free from snow in summer, whilst the Sáser further south is seldom, if ever, free from snow.

Western Tibet.

Regarding the height of perpetual snow on the tableland of western Tibet Captain H. Strachey is still the best authority. He writes:—"from a series of minute observations on the snow-level, made during two years, in the course of which I crossed twenty-five passes elevated from 15,000 to 19,000 feet at various seasons between the end of

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[1] Tours in the Himálaya, II., 73, 117, 133, 242: Account of Koonawur, 157-9.
[2] Travels, p. 437. [3] Report, p. 11.

April and the beginning of November, I have arrived at the following conclusions. The snow-line in the central and northern parts of west Nári attains an extreme height of nearly 20,000 feet. It lowers on approaching the Indian Himálaya, and on the southernmost parts of the Indian watershed descends perhaps as low as 18,000 feet." The mountains under 20,000 feet in height in the northern and more open parts of the tableland will, he adds, be almost entirely denuded of snow during the latter part of the summer. General Strachey, during his visit to the tableland north of Garhwál during September, 1848, found snow only in patches in sheltered ravines, but the highest summits in the district through which he passed were only 18,400 feet. Perpetual snow was not found on any of the hills between the Indian water-parting and the Satlaj. The height of the snow-line on the south face of the peak of Kailás was observed in the month of September by means of a theodolite, and found to have an elevation of nearly 20,500 feet, and the altitude of a peak on the ridge between the Satlaj and the Indus which was only tipped with snow in August was in like manner determined to be 20,500 feet above the sea: so that, making a fair allowance for the difference between the northern and southern exposures, the mean snow-line was in both cases about the same. The limit of snow on the Pámír is reported to be between 16,000 and 17,000 feet and on the Alái Pámír about 14,000 feet.

Lakes.

Throughout Kumaon and Garhwál there are several lakes, but the chief in size and beauty occur in pargana Chhakháta, the Westmoreland of Kumaon. These are known as Naini, Bhím, Sát, Naukuchiya, Malwa, Khurpa, Sukha, Sariya, Khuriya, &c., with the affix '*tál*' or 'lake' attached. The following table gives some information regarding the principal lakes:—

Name.	Height above sea-level.	Greatest length.	Greatest breadth.	Greatest depth.	Approximate area.
	Feet.	Feet.	Feet.	Feet.	Square feet.
Naini Tál ...	6,407	4,733	1,518	93	5,149,000
Bhím Tál ...	4,500[1]	5,580	1,490	87	4,900,000
Naukuchiya Tál ...	4,000[1]	3,120	2,270	132	4,849,500
Malwa Tál ...	3,400[1]	4,480	1,833	127	4,909,600

[1] Approximate measurements.

It has been suggested that these lakes were formed by glacial action, but Mr. Ball in a recent paper[1] combats this view, and assigns their existence to landslips which closed up the valleys in which they occur. Be this as it may, they form one of the most remarkable and beautiful features of the Lower Himálaya in Kumaon. The lake of Naini lies in a valley which runs about north-west and south-east, and is surrounded on all sides except the east by lofty ridges, Sher-ka-danda, China (8,568 feet), Deopátha (7,989 feet), and Ayárpátha (7,721 feet). Bhím Tál lies in a comparatively open valley with a hill to the south of the lake rising some 1,300 feet above its level. Further east in the same valley is Naukúchiya Tál, occupying a hollow in the slope, and without any remarkable hills around it. The Sát Tál or seven lakes, lie within a circle of hills between Bhím Tál and the valley of the Naini Tál river, and Malwa Tál lies to the north of Bhím Tál in a deep valley, the sides of which rise up abruptly from the level of the lake. The only lakes of importance in Garhwál are the Gudiyar Tál in patti Dasauli Malli and Diuri Tál in patti Káliphát Malla, neither of which can compare with the Kumaon lakes in size or beauty.

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[1] Rec., Geo. Sur., XI, 2, p. 174.

CHAPTER V.

METEOROLOGY.[1]

CONTENTS.

Preliminary sketch of climate. Contrast between the eastern and western parts of the plain and the Himálaya. Radiation, solar and nocturnal. Temperature :—Diurnal and annual ranges,—Vertical decrement,—Height of snow-line. Pressure and winds :—Barometric tides,—Mountain winds,—Annual variation of pressure,—Monsoons. Humidity :—Vertical distribution of vapour,—Relative humidity,—Cloud. Rainfall :—Distribution on plains and on the Himálayan slope,—Annual variation,—The winter rains,—The monsoon rains.

THE climatological conditions of these hill districts are a most important element in their physical geography, and will therefore require to be treated at considerable length. An exhaustive discussion of the meteorology cannot yet be attempted, but sufficient data have already been collected to serve as a basis for a general description of the climate, and at the same time to throw some light on several of the more interesting problems of meteorology. In this latter respect the Himálaya, on account of its less distance from the equator and its greater elevation, presents many points of advantage as compared with the Alps and other European mountain systems ; and already some important general conclusions regarding the physics of the atmosphere have been drawn from the observations that have been made in it. The mere statement of the fact that nearly all the snowy peaks and most of the passes over the Indian watershed stand above the lower half of the atmosphere, and thus completely cut off all communication between India and Central Asia, except in the upper strata, indicates how much regarding the general movements of the atmosphere may be learnt from observations taken in India and the Himálaya.

Of late years, a good deal has been done in the way of collecting trustworthy meteorological data for the mountain zone by the establishment of Government observatories at certain points. The places where observations are made at the public expense must always, however, be few, and it is desirable that more should be done in the way of enlisting the services of volunteer observers. Temperature and rainfall observations are now made at many tea-gardens in Kumaon; but, as a rule, so little attention is paid to the hours of reading, the exposure of the instruments, and the continuity of the registers, that the results are of no value for scientific discussion and comparison. By far the most important of the observations taken in the north-west Himálaya, prior to the establishment of regular observatories, were those collected by Lieutenant (now General) R. Strachey, of the Bengal Engineers, in 1848 and 1849. Some of General Strachey's deductions from them have been given to the world in the *Proceedings of the Royal Society* and the *Journal of the Asiatic Society of Bengal;* but others have not yet been published, though they were long ago embodied in a work on the "Physical Geography of the Himálaya" that has been placed at the disposal of the compiler of this volume. Considering the scanty nature of the materials General Strachey had to work with, the conclusions arrived at were wonderfully accurate; and though some of them were opposed to the generally received opinions of the European meteorologists of the day, they have been confirmed in almost every respect by the more extensive data subsequently obtained from the Himálayan observatories.

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[1] Written by Mr. S. A. Hill, Meteorological Reporter to the Government of the North-Western Provinces and Oudh, for this volume.

In the following pages a somewhat detailed discussion of all the data available for meteorological inquiry will be given after a brief general sketch of the climate. The several elements of meteorological observation will be taken in the natural order of cause and effect, commencing with solar radiation and afterwards passing on to temperature, barometric pressure and winds, and the distribution of vapour and rain.

Sketch of climate.

The order of the three seasons on the plains of Upper India—the cold, the hot, and the rainy—is now well known even in Europe. After the close of the rains at the end of September or beginning of October the sky is serene and the atmosphere transparent. Owing to the absence of cloud and the rapidly diminishing proportion of water vapour, the air is also very diathermanous; that is, it permits the free passage of heat from the sun to the earth in the daytime, and in the calm nights that prevail at this season the radiation of heat into space goes on so rapidly that the earth's surface and the air resting on it become very cold before morning. The months of October and November are thus characterized, not only by clear skies and calms, but by a great temperature range and heavy dews at night. These conditions prevail through the greater part of December, and towards the end of that month and in the beginning of January, the exposed thermometer sometimes falls 10 degrees below freezing at places as far down the plain as Allahabad and Benares. In the Panjáb it is much colder, and there the shaded thermometer sometimes reaches the freezing point.

About the end of December and in January and February, however, clouds often interfere with the free radiation of heat at night, and the daily range of temperature for these months is less, on the average, than that of November. Some rain usually falls at this time of the year, especially in the Panjáb and the higher districts of the North-Western Provinces. In March and April the temperature rises rapidly, especially at a distance from the mountains, and the air becomes extremely dry. Hot winds from the west or north-west blow down the valley of the Ganges and rapidly change the appearance of the whole country from that of a highly cultivated plain to a parched and sandy desert, almost the only green things left being the groves of mango trees. In April, the daily range of temperature over the plains is at a maximum, exceeding 30 degrees in most parts of the North-Western Provinces and the Panjáb. The nights are still tolerably cool, though in the day-time the thermometer ranges as high as 110° F. or even higher sometimes.

During May and the first half of June the temperature continues to increase, though much less rapidly than in March and April, until by the 15th or 20th of June, if the periodical rains have not commenced, the temperature is probably higher in North-Western India than anywhere else in the world. In the North-Western Provinces the shaded thermometer has only been known to rise once or twice above 120° F., but in the Panjáb temperatures as high as 123° or 124° have been recorded. The days in June are thus only a few degrees hotter than those of April; but, as the rainy season approaches, the range of temperature diminishes and the nights become insufferably hot and close.

Rain seldom falls in the hot weather, the falls that do occur generally taking place during thunderstorms. About the middle of May, however, the quantity of water vapour in the air begins to increase rapidly, betokening the approach of the rainy season. This vapour is probably brought by the prevailing south-west upper current of the atmosphere which seems to descend gradually until it merges with the surface sea winds of the Bay of Bengal and forms "the south-west monsoon" or prevailing wind of the rainy season. In Northern India the lowest strata of the sea winds are deflected from their normal course by the mountains and directed towards the seat of highest temperature in the Panjáb, thus appearing as east or south-east and not as south-west winds. Along the foot of the hills these easterly winds are felt occasionally by the middle of May, when the quantity of vapour in the air first begins to show signs of a rapid increase.

During the latter half of June the sea winds increase in strength and gradually advance along the foot of the Himálaya, until, by the beginning of July, the rains have usually set in all over Northern India. In ordinary years rain continues to fall, not steadily but with frequent intermissions or "breaks," until about the end of September, when the easterly winds cease, except close to the hills, where they last a month longer, and are succeeded by calms or feeble currents from the west. In the Panjáb the rains begin later, are lighter and more intermittent, and end sooner than in the North-Western Provinces, and the length and intensity of the rainy season increase regularly as we approach the sea in Bengal. During the rains the temperature averages about 85° over the greater part of Northern India. The daily range at this time varies from 8 to 12 degrees, being greatest in the driest districts.

The extremes of heat and cold are much greater in the Panjáb and the upper part of the North-Western Provinces than in Bengal, for two reasons—the greater distance from the sea and the higher latitude. On account of its proximity to the sea and its heavy rainfall, Bengal is moist and cloudy at all seasons compared to the Panjáb. This condition of the atmosphere, by retarding the radiation of heat, renders the climate of Bengal more equable than that of the Panjáb, just as an insular climate is more equable than a continental one. Again, the latitude of the Panjáb, which is 7 or 8 degrees higher than that of Bengal, causes its winters to be much colder and its summers much hotter. At first sight it seems anomalous that a place should be the hotter the more distant it is from the equator, at any season of the year; but when it is borne in mind that the quantity of heat received from the sun is directly dependent upon the length of the day as well as on the elevation of the sun above the horizon, the anomaly disappears. Various mathematical physicists from Halley downwards, including Poisson[1] and more recently Meech,[2] have calculated the total heating effect of the sun in different latitudes during a day or other given period of time. The latest investigation of this kind has been made by Wiener[3] of Carlsruhe, who finds that while the maximum of heat for the whole year falls on the equator, the maximum for the 21st of June is at the north pole, where the sun remains above the horizon for twenty-four hours, and has an altitude of nearly 23½ degrees for the whole of that time. In the summer half year, from equinox to equinox, most heat falls on a zone about 25½° north of the equator, and during the three months nearest to the summer solstice—that is, from the 7th of May to the 6th or 7th of August, the zone of greatest heat lies about 41°N. The total heat received during these three months by an area in latitude 40° or 41°N. is more than a fifth greater than that which falls on an equal area at the equator. The actual increase of temperature produced is much more than this, for the mean temperature is determined by the balance between the gain of heat during the day and the loss at night. When the gain of heat from the sun at any place is greater than at the equator, on account of the length of the day, the loss at night must be correspondingly less.

This excess of solar heat in summer, together with the dryness of the air and the absence of cloud, seems to account for the excessively high temperature of June and July in the extreme north of the Panjáb and on the plains of Yárkand and Káshgar still farther north. In the moister zone of the mountains, the direct action of the sun is less observable; but beyond the Indian watershed it is by far the most important factor in determining the character of the seasons.

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[1] *Theorie de la Chaleur*, 1835 edition, page 478. [2] *Smithsonian Contributions to Knowledge*, Vol. IX. [3] *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie*, Band XIV, page 133.

Regarding the succession of the seasons in the mountain zone, General Strachey says :—

"The same general sequence of the seasons takes place in the mountains as in the plains. Here, however, every altitude has its own special temperature, from the lower valleys where the heat is still overpoweringly great, to the regions of eternal frost ; but at all elevations in summer the force of the sun's rays is excessive. The summer rains, too, gradually diminish in strength as we move along the chain from east to west, being at their maximum in Sikkim, but still being felt slightly on the ranges north of Peshāwar. The heaviest falls invariably take place on those portions of the chain most exposed to the south ; increasing in amount up to a certain height [not very exactly determined, but probably about 4,000 feet]; at the same time every high and continuous ridge most sensibly diminishes the supply of rain that falls on the country to the north of it, and we find, as we approach the Indian watershed, that the quantity is very small, and that the monsoon only just drops a few partial showers on the southern border of Tibet. The winter, as may be supposed, is extremely rigorous on the summit of the table-land ; and at this season, or in spring, the only important precipitations of moisture take place in the form of snow, but they are exceedingly small in quantity."

The reason why every altitude has its own special temperature is that the air is warmed chiefly by contact with the hot ground on which it rests, and but little by direct absorption of the solar rays. The air in contact with the ground, expanding and becoming less dense, rises up, but in doing so its heat is rapidly converted into the work of expansion ; the result being that the temperature of the upper strata can never rise so high, on the average, as that of the air near the ground. Dry air, if heated only at the bottom, would lose 1 degree Fahrenheit for every 183 or 184 feet of ascent. In moist air that is precipitating rain, and thus being warmed by the latent heat of the condensed vapour, the rate of decrease is much less. The rate actually observed, both in balloon ascents and on mountain sides, is less than that calculated theoretically ; because even dry air is to some extent warmed directly by the sun's rays, while air saturated with moisture has a very considerable absorbing power. On mountain slopes also the temperature falls less rapidly than in the free air over the plains—at all events for the first nine or ten thousand feet of ascent, the reason being that the air is heated by contact with the mountain sides.

Radiation.

No data at present exist from which the average intensity of solar radiation, and its variations from time to time, can be estimated with any approach to exactness. Any deductions made by passing from radiation to other meteorological phenomena must therefore to a great extent be based on theoretical considerations.

The instrument hitherto used to measure the intensity of the sun's heat has been a maximum thermometer with a blackened bulb surrounded by a thin glass case more or less completely exhausted of air. If the exhaustion were perfect, the temperature of the instrument would be determined by radiation to and from surrounding objects; including under these the glass case of the instrument which is in contact with the air, the sun, the ground, the clouds, and the open sky. Were solar thermometers all made exactly alike and exposed under absolutely identical conditions, the excess temperature of the instrument above the contemporaneous temperature of the air would be a measure of the excess of radiant heat falling on it from objects above the horizon over that which passes away from it in an upward direction. The following table gives the average value of this difference for each month at six stations. Corrections have been applied as far as possible for differences of instrument and exposure, except at Dehra, for which the corrections are not known:—

I.—Monthly mean excess temperature of the solar thermometer above the maximum in shade.

Stations.	Elevation in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
		°	°	°	°	°	°	°	°	°	°	°	°	°
Leh ...	11,538	49·9	68·1	62·3	63·2	58·7	58·1	54·1	62·8	63·8	68·9	54·1	50·9	58·7
Chakráta,	7,052	71·1	67·1	69·4	69·5	69·1	66·3	63·0	61·5	70·3	69·8	69·4	68·5	67·9
Ránikhet,	6,069	61·1	60·6	62·6	60·4	60·3	57·1	50·8	52·1	59·8	57·3	52·7	55·7	57·3
Dehra ...	2,232	51·0	52·2	57·6	57·1	56·8	54·2	53·6	52·1	57·7	58·5	55·6	51·8	54·9
Roorkee...	887	52·2	51·5	55·9	54·6	53·7	51·2	51·9	51·8	54·5	54·5	55·1	52·5	53·3
Bareilly ...	568	50·0	52·6	54·1	54·4	55·3	54·2	50·7	50·1	49·3	52·0	52·4	48·9	52·0

If the air were absolutely diathermanous, the altitude of the sun above the horizon and the vertical thickness of the atmosphere above the place of observation should have no effect upon the temperature differences in the table, which should therefore be the same for all the stations and for every month of the year. But the air having some absorbing power, the differences should be greatest when there is least air for the sun's rays to pass through; that is, at the highest stations and in the summer months. Up to Chakráta the excess temperature of the solar thermometer does increase with a fair degree of regularity; but it appears to be less at Leh than at Chakráta, contrary to all theory. There is also no regular increase apparent in the heating power of the sun as the season changes from winter to summer. The truth is that the indications of the black-bulb thermometer are affected by so many disturbing causes, that after all possible corrections they are of little or no value for intercomparison; though with the same thermometer, at the same place, and under absolutely constant conditions of exposure, the figures for one year may be to some extent comparable with those for another.

The results of observations with the nocturnal radiation thermometer are even more unsatisfactory, owing to differences in the height of the instrument above the ground and in the nature of the ground surface itself, whether grassy or bare.

II.—Monthly mean depression of the grass thermometer below the minimum in shade.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Chakráta,	9·5	6·5	7·2	7·5	6·3	6·0	3·1	4·3	5·3	8·8	9·8	11·0	7·2
Rânikhet.	14·5	13·6	13·9	13·3	12·0	9·0	5·3	6·0	8·9	13·5	17·2	19·1	12·2
Dehra ...	4·4	4·4	4·2	4·7	4·8	3·6	2·2	1·5	2·3	3·5	4·8	4·6	3·8
Roorkee...	6·3	5·8	6·4	6·3	5·0	3·5	2·4	2·9	3·9	6·3	7·3	6·3	5·2
Bareilly...	7·0	7·5	8·0	10·0	10·5	8·8	4·3	3·3	3·4	6·4	8·2	8·0	7·1

The figures in table II. serve to show that the depression of the nocturnal radiation thermometer below the minimum in shade is less in the rainy season than in the dry, and that both at the hill stations and on the open plain the refrigeration of the earth's surface during the night is probably greater than at Dehra, where the observatory is situated in a well-wooded park. They do not throw any light on the question whether the ground surface cools more rapidly at night on mountain tops or on the plains; though it is probable that in the clear, calm nights of the cold weather the difference, if any, is in favour of the plains; since there the air cooled by contact with the ground remains in contact with it, whereas on the mountains the cooled air constantly drains away, and is replaced by warmer air from the surrounding free atmosphere.

Temperature.

It has been already stated that, in the western Himálaya, every elevation has its characteristic mean annual temperature. Each elevation has probably also a distinctive form of variation of temperature during the year, and the daily variation is different at different altitudes, in range if not in general form.

For a proper discussion of the distribution of temperature in a hilly country a very large number of observations would in most cases be required; and these should be made at places chosen so as to be at nearly equal distances from each other vertically, and at the same time fairly distributed in latitude and longitude. On the southern slope of the Himálaya it fortunately happens that differences of latitude and longitude make but little difference in the mean annual temperature. The sea-level values of the mean temperature at the Sub-Himálayan stations from Lower Asám to Ambála all lie between 76 and 78 degrees Fahrenheit, and the temperatures of places at about 7,000 feet elevation along the whole range from Darjíling to Marri in the north of the Panjáb do not differ more than 2 or 3 degrees.

Both along the plains and at the level of the hill sanitaria the highest mean temperatures are found to characterize the regions lying between the Káli and Satlaj rivers. The chief reason for the great uniformity of mean temperature at the same elevation that prevails over the whole Himálayan region—that is to say, through more than 7 degrees of latitude and 17 of longitude—is the greatly increased heat of summer in the north-west as compared to the east. In Bengal and Sikkim the sun's rays when most intense are to a great extent cut off by cloud, whereas in the Panjáb and the north-west Himálaya the winter is almost if not quite as cloudy as the summer. For these reasons Darjíling has very nearly the same temperature in January as Simla, Chakráta, or Mussooree, while in May and June it is seven or eight degrees cooler. The comparatively low temperature of the summer at Darjíling renders the mean for the year nearly two degrees lower than that of Marri in the extreme north-west, though the effect of latitude is apparent in the low temperature of Marri in January.

On account of this uniformity of temperature a small number of observations, at places chosen specially with reference to height above the sea, will enable us to ascertain the most important features of temperature distribution in the Himálayan districts of the North-Western Provinces. The following table gives the mean monthly temperatures of twenty-one places, including the two stations on the plains that were given in the previous tables. All the other places except Dharmsála lie in one or other of the three districts of Kumaon, Garhwál, and Dehra Dún, or in parts of Kunáwar, Lahúl, and Ladák to the north of Dehra Dún. The monthly means from a Government observatory at Dharmsála in the Panjáb have been inserted, though this station lies nearly two degrees west of Dehra Dún, because it was considered desirable to have some trustworthy figures for places about 4,000 feet above the sea; and the only other station near that altitude is Háwalbágh in Kumaon, for which we have but one year's observations.

III.—Mean monthly and annual temperatures of places in Kumaon, Garhwál, Dehra Dún, and adjacent districts.

Place.	Latitude N.	Longitude E.	Elevation in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
BAREILLY ...	28°21′	79°27′	568	37·9°	63·0°	73·0°	83·4°	89·1°	90·3°	84·8°	84·0°	83·0°	76·4°	66·5°	58·6°	75·8°	11
ROORKEE ...	29 52	77 56	887	36·7	61·1	70·5	81·5	87·9	90·8	85·2	84·1	82·7	73·5	65·0	57·5	74·9	17
Srinagar ...	30 13	78 50	1,930	...	...	...	71·0	80·0	84·0	79·0	84·0	79·0	...	...		...	1
Kálsi ...	30 30	77 50	2,000?	58·3	61·0	62·6	77·7	81·2	86·0	83·7	80·2	77·2	70·8	63·2	59·7	71·8	1—2
DEHRA ...	30 20	78 8	2,233	54·8	58·0	63·8	76·1	82·1	84·9	80·2	79·0	77·3	70·4	62·5	56·2	70·6	12
Háwalbágh ...	29 38	79 37	4,114	47·0	53·0	61·0	66·0	73·0	76·0	78·0	79·0	75·0	69·0	60·0	52·0	65·8	1
DHARMSÁLA ...	32 20	76 33	4,495	44·6	49·4	57·3	68·3	72·3	75·8	70·7	69·6	69·0	64·6	57·7	50·5	62·5	4—5
Pauri ...	30 10	78 55	5,350	—	...	...	60·0	69·0	73·0	72·0	69·0	67·0	61·0	...	...	...	1
Almora ...	29 35	79 38	5,346	46·3	52·2	57·4	64·7	70·3	75·0	73·2	72·5	72·5	65·4	57·9	51·2	63·2	6—7
Lohughát ...	29 24	80 4	5,649	44·5	43·8	52·3	60·9	66·0	71·0	71·1	70·7	68·7	63·1	51·9	46·4	59·4	2—3
Mussooree (1) ...	30 24	78 10	5,850	45·6	47·0	57·2	63·5	67·0	70·8	66·4	65·3	65·2	63·0	56·6	47·6	59·6	1—3
RANIKHET ...	29 38	79 29	6,069	46·1	49·2	56·3	65·2	67·8	71·3	67·9	67·2	66·4	61·0	55·7	50·2	60·4	9
Naini Tal ...	29 20	79 31	6,463	42·8	45·3	55·5	60·4	66·0	69·1	68·4	67·3	65·4	59·8	52·7	46·6	58·2	10
Mussooree (2) ...	30 28	78 7	6,937	41·5	43·6	52·0	59·6	65·6	68·5	64·7	64·1	63·0	57·3	52·3	46·5	56·7	2—14
CHAKRÁTA ...	30 40	77 53	7,052	41·6	43·7	50·4	59·6	64·6	68·0	64·5	64·1	63·0	57·5	52·2	46·6	56·3	11
Landaur ...	30 27	78 11	7,311	37·8	44·1	49·4	56·3	63·2	68·5	65·3	63·9	64·3	56·4	49.4	44·1	55·2	4—5
Kánam (Kunáwar)	32 0	78 30	9,296	26·8	34·6	37·2	46·6	56·7	68·7	66·6	65·0	61·3	54·1	42·6	36·1	49·4	2
Kardong (Lahúl),	32 34	77 1	10,242	24·0	36·0	44·0	47·0	49·0	54·0	65·0	60·0	52·0	46·0	37·0	27·0	44·9	1
Níti ...	30 48	79 34	11,464		...	..	...	...	...	58·0	58·0	55·0	...	...	—	...	1
LEH (Ladák) ...	34 10	77 42	11,538	17·6	22·1	30·3	40·1	46·6	53·6	60·5	57·5	49·9	37·9	30·7	24·4	39·2	2—7
Spiti Valley ...	32 10	78 0	12,000	17·5	18·7	22·3	37·5	45·9	56·9	61·7	53·3	52·7	30·8	22·6	17·2	37·2	1

Authorities for the above table.

BAREILLY : Registers of the Government Meteorological Observatory, 1869 to 1879

ROORKEE : Ditto, ditto, 1863 „ 1879

DHARMSÁLA : Ditto, ditto, 1871 „ 1875

RÁNIKHET : Ditto, ditto, 1871 „ 1879

CHAKRÁTA : Ditto, ditto, 1869 „ 1879

LEH : Ditto, ditto, 1871 „ 1877

DEHRA : Registers of the Observatory at the G. T. Survey Office, 1868 „ 1879

NAINI TAL : Registers of Government Observatory, 1868 to 1869; and observations by Dr. Payne in 1851-54, given at page 496 of the third volume of the *Results of a Scientific Mission to India and High Asia*, by the brothers Schlagintweit.

MUSSOORIE (1): Records of an observatory at Saint Fidelis's School for 1877-80; somewhat fragmentary.

(2): November to April, Sir A. Waugh's and Mr. Mackinnon's observations in 1853-36, also one year's observations from Dove's tables; May to October, observations at the Survey Office for 1866-79, furnished by Mr. Hennessey, F.R.S.

LANDAUR : Registers kept at the Convalescent Hospital in 1852-54, and 1866-67. Observations for the three years 1877-79 have been communicated by the medical officer in charge, but the means deduced from them appear to be 4 or 5 degrees too high.

KÁLSI : Pigot—*Calcutta Journal of Natural History*, Vol. VI., 1837-38.

ALMORA : Observations at the Regimental Hospital. 1852-54 and 1866-69.

HÁWALBÁGH : Schlagintweit, page 494, on authority of Mr. Batten; year unknown.

LOHUGHÁT : Clelland's *Geology of Kumaon*, page 179: parts of 1830, 1831, 1834, and 1835.

KARDONG : Schlagintweit, page 513; 1855-56.

KANAM : Cunningham's *Ladák*, page 184;[1] 1827-28.

SPITI VALLEY : Ditto, page 183;[2] 1846.

SRINAGAR :
PAURI :
NITI :
} Manuscript observations by General Strachey and his brothers, 1847-49.

The figures for the regular meteorological observatories (printed in small capitals in table III.) and those for the observatory at the Survey Office, Mussooree, are either directly calculated from observations at 4 A. M., 10 A. M., 4 P. M., and 10 P. M., or have been corrected to represent the means of observations taken at these hours. They probably differ very little from true daily means. The mean temperatures for the other places have been calculated in various ways, and many of them are open to considerable doubt.

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[1] Recomputed from the maxima and minima and corrected by means of the observations of Chakráta and Leh.

[2] Recomputed and corrected by the Leh observations.

The mean annual temperature diminishes pretty regularly as height increases. In the table there are only two exceptions to the rule that the higher a place is the cooler it is. It will be seen also on comparing places of nearly equal altitude and not very far apart that the highest temperatures belong to those which, lying behind the outermost high ridge, are subject to a much smaller rainfall than stations situated on the ridge or in valleys opening out to the south and exposed to the full force of the rainy winds. Thus Ránikhet and Almora are too hot in comparison with Naini Tál. The difference in temperature as well as in humidity between places situated at equal heights on the outer and inner ranges of Kumaon is sufficiently great to be easily recognizable without the aid of instruments, and is well known to all who have ever resided in the hills. The variation of temperature between the hottest and coldest months and the daily range of the thermometer are also greater, as a rule, in the interior than on the outer hills, owing to the larger proportion of cloudy sky and greater humidity of the air in the latter region.

Both the diurnal and the annual range of temperature decrease on ascending from the plains up to a height of 6,000 or 7,000 feet, and beyond that they again increase, their greatest values being attained at the highest stations where observations have been made. These places, however, lie to the north of the Indian watershed, where the humidity is doubtless less than on the southern side, and the observed ranges of temperature are probably higher than they would be at equal altitudes on this side of the snowy range. Moreover, the annual range in Tibet and Ladák is greater than on the Indian side of the chain on account of the difference of latitude, as has already been pointed out. In table IV. the daily and yearly ranges of temperature at twelve places are compared, and from it these relations will be readily seen.

IV.—Mean diurnal and annual ranges of temperature at places in the Himálaya.

Place.	Diurnal Range.													Annual range of monthly means.
	January.	February.	March	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Bareilly ...	26·3	25·5	28·0	31·0	28·3	22·1	14·2	14·2	15·0	24·3	30·4	28·0	23·9	33·0
Roorkee ..	26·5	24·6	28·3	31·4	28·9	22·2	14·5	14·6	17·2	27·8	32·9	29·3	24·8	34·1
Dehra ...	23·4	23·1	24·0	26·3	24·8	18·6	12·8	12·5	15·0	23·4	25·9	24·3	21·2	30·1
Dharmsála ...	15·8	18·6	20·4	21·3	21·6	18·2	12·6	12·6	15·4	19·6	20·2	18·5	17·9	31·5
Mussooree, (1),	14·0	13·2	14·0	16·0	19·3	15·4	9·4	8·0	10·3	13·6	16·3	12·3	13·2	25·2
Ránikhet ..	16·1	17·0	18·2	18·6	18·1	15·0	11·2	10·9	13·1	15·3	17·2	16·1	15·5	25·2
Mussooree, (2),	...	...	...	...	19·0	16·5	10·7	9·9	12·0	14·2	16·8	...	...	27·0
Chakráta ..	18·3	18·4	18·1	19·7	19·4	16·3	12·3	11·3	12·0	17·3	18·0	18·3	16·6	26·4
Landaur ...	15·3	18·7	18·2	19·7	20·0	21·2	13·1	9·5	12·2	16·5	17·0	18·2	16·6	28·8
Kanam ...	15·2	17·2	22·0	19·0	18·5	17·3	16·3	13·5	88·9	20·5	19·0	18·3	18·1	37·8
Leh ...	28·5	30·0	28·0	31·0	30·1	31·8	11·2	31·3	31·4	30·5	26·7	25·2	29·6	42·9
Spiti ...	19·3	27·7	29·2	18·5	22·0	29·0	32·1	31·3	28·4	28·0	18·0	32·2	28·7	44·5

The table shows clearly that the minimum range for both day and year is reached at Ránikhet and the lower Mussooree station—that is, about 6,000 feet above the sea. The dependence of the diurnal range upon the humidity of the air and the proportion of cloud at each station is distinctly brought out in the variations from month to month. At all the stations but Leh and the Spiti valley, which lie beyond the snowy mountains, the months of the year which are driest in India—April and May—have the largest daily thermometric range, and the most humid months—July and August—have the smallest. There is a secondary minimum of temperature range coinciding with a maximum of humidity in January, and a secondary maximum in the dry and cloudless month of November. At Leh, where the most frequent precipitation of moisture during the year takes place in winter, the range is somewhat greater in the summer than in the winter months.

Owing to the greater annual range of temperature on the plains than on the hills, the diminution of temperature in the first 6,000 feet of ascent is most rapid in the hottest months and least so in the cold season. Between Roorkee and Chakráta the difference is less than 11 degrees in December and more than 23 in May. In the clear still nights of the cold weather, especially in November and December, before the winter rains and snows set in, the nocturnal loss of heat goes on almost as freely on the plains as on mountain peaks. It is thus not unusual to find the temperature of the exposed thermometer at Roorkee nearly as low as at Chakráta, and it very frequently falls lower at Roorkee than at Dehra, where the observatory is surrounded by trees. In December the mean temperature diminishes between Roorkee and Dehra at the rate of only one degree in 1,034 feet, while in May and June it falls one degree in 230 feet.

The low temperature of the plains in the winter season, especially in the morning, is doubtless due in part to the draining down of cold air from the mountain slopes through the river gorges. This, however, cannot appreciably affect the temperature of places at a long distance from the mountains, though it may have a very considerable effect on that of Roorkee, close to the foot of the Siwáliks. The minimum temperature of the day is thus one or two degrees lower on the average at Roorkee than at Dehra in the months of November and December, and in January the minimum temperatures of the two places are equal. In the mountain country itself it often happens for the same reason that the temperature of the air at the bottom of a valley is distinctly lower than on the adjacent ridges. A similar inversion of the normal variation of temperature with height has been noticed in Europe during calm weather in winter.

From March to June the absorption of heat in melting and evaporating the snow on the outer hills, and in evaporating the rain that falls there in frequent showers when no rain falls over the plains, keeps down the temperature; so that in May and the first half of June, when the plains are at their hottest, the decrease of temperature on ascending through 6,000 or 7,000 feet is more than twice as great as in December.

In the Panjáb, where the latitude is higher and the humidity of the air over the plains is never great, the annual range of temperature at places on the plains is higher than in the North-Western Provinces, while in the hills there is much less difference. The annual variation in the decrease of temperature with height is accordingly much more distinctly marked in the extreme west of the Himálaya than it is in Dehra Dún. The difference of temperature between Ráwal Pindi and Marri is 19·5 degrees in July and only one-third as great in December. On the other hand, in the eastern Himálaya, where the air at all elevations up to 9,000 or 10,000 feet is nearly equally moist, and where the range of temperature, especially over the plain, is much less than in the north-west, the decrease of temperature with height is most rapid in February and March and least so in June and July. The slow rate of decrement in the rainy season is doubtless due to the liberation of latent heat in the condensation of vapour; this heat rendering the atmospheric strata in which condensation occurs warmer than they otherwise would be, while the constant precipitation of rain prevents the lower strata from becoming very much hotter than the rain drops which pass through them. The effect of the rainy season in retarding the fall of temperature as we ascend is distinctly seen between Bareilly and Naini Tál or Ránikhet, but is not seen between Roorkee and Chakráta.

The great annual range of temperature at more elevated stations, especially such as lie behind the first snowy range and receive little or no precipitation, causes even greater differences in the rate of decrease of temperature with height, but in the opposite direction. In January, the difference of temperature between Chakráta and Leh is 24 degrees, but in August it is only 4 degrees. The greater length of the day in summer at Leh, and the absence of cloud to obstruct solar radiation on the surrounding mountain sides, render the summer months at that station, 11,500 feet above the sea, as hot as they would be on the southern side of the snowy mountains at an elevation of 8,500 or 9,000 feet. If General Cunningham's figures for the temperature of the Spiti valley are to be trusted, the heat of summer at an elevation of 13,000 feet is still more excessive. The relation of this to the greater height of the snow-line on the northern than on the southern side of the Himálayan system is obvious.

In the following table the mean rate of decrease of temperature in the first 6,000 or 7,000 feet of ascent has been worked out for each month. In Dehra Dún the lower station is Roorkee and the upper one Chakráta; in Kumaon, Bareilly has been taken for the lower station, and instead of choosing either Naini Tál or Ránikhet for the upper one, the monthly mean temperatures of both places have been taken and assigned to the mean elevation of the two. This was considered preferable to taking the figures for either hill station alone, because Ránikhet appears to be a little hotter than the average of places at the same elevation, and Naini Tál is probably somewhat cooler than the average.

V.—Decrement of temperature with height in the Himálaya.

Month.		*Dehra Dún, difference of elevation, 6,165 feet.*		*Kumaon, difference of elevation, 5,698 feet.*		*Mean rate of decrease.*	
		Difference of temperature.	Height for 1°.	Difference of temperature.	Height for 1°.	Height for 1°.	For 1,000 feet.
		°	Ft.	°	Ft.	Ft.	°
January	...	15·1	408	12·9	442	425	2·35
February	...	17·4	354	15·7	363	358	2·79
March	...	20·1	307	17.1	333	320	3·13
April	...	22·9	270	20·6	278	274	3·65
May	...	23·3	265	22·2	257	261	3·83
June	..	22·8	270	20·1	283	277	3·61
July	...	20·7	298	16·7	341	319	3·14
August	...	20·0	308	16·7	341	325	3·08
September	...	19·7	313	17·1	333	323	3·09
October	...	18·0	343	16·3	350	356	2·81
November	...	12·8	482	12·3	463	473	2·11
December	...	10·9	567	10·2	559	563	1·78
Year	...	18·6	331	16·5	345	338	2·96

In Dehra Dún there is a regular annual periodic variation in the rate of decrease of temperature with height, but in Kumaon the regular variation is interrupted in July and August, when the rate of decrease is slightly retarded by the fall of rain, as has been explained above. When the mean for both districts is taken, the regular variation from month to month is only slightly broken in August.

The figures given in the table include not only the decrease of temperature due to increase of elevation above the sea, but also a certain diminution caused by an increase of latitude equal to about a degree in 6,000 feet of elevation. The change of temperature with latitude in the Himálaya is small and to some extent masked by the contrast between the sunny valleys of the interior and the cool and cloudy outer ranges, but nevertheless it exists. On the plains of the North-West Panjáb the temperature falls as the latitude increases at a mean rate of about 1·1° F. for each degree of latitude, when corrections are made for differences of height above the sea. Probably much the same rate obtains in the western Himálaya at moderate elevations. The mean temperature of Yárkand, in latitude

39° N. and 4,200 feet above the sea, appears from the observations of Captain Trotter, R.E., of Drs. Bellew, Henderson and Scully, to be about 54°F. At the same elevation in Kumaon the mean temperature is between 65° and 66°, and since the difference of latitude is ten degrees, the temperature appears to diminish about 1·1° or 1·2° for a degree of latitude. There is also a certain variation of the mean temperature with the longitude, places situated towards the east of the chain being cooler than those towards the west on account of the cloudiness of the summer months. In order to determine the true variation of temperature with height it is necessary to make allowance for these variations in latitude and longitude. The mean annual temperature of any place in the western Himálaya may thus be looked upon as a function of four quantities—(1) the sea-level temperature at a point taken as the zero of latitude and longitude, (2) a constant multiplied into the height of the place above the sea, (3) a constant multiplied into the latitude, and (4) a constant multiplied by the longitude. From the Schlagintweits' work and the reports of the Indian Meteorological Department fairly trustworthy mean temperatures for about thirty places in the Himálaya between the Nepál frontier and the Indus can be obtained, more than half of these being given in Table III. When treated by the method of least squares the observations admit of being thrown into the form $T = 78{\cdot}5^\circ - {\cdot}00277h - 1{\cdot}20\,(\lambda - 29^\circ) - {\cdot}105\,(L - 73^\circ)$, a formula which represents the observations with a mean error of about three-quarters of a degree. It ignores, of course, the differences of temperature between such places as Almora or Ránikhet and others of equal elevation on the outermost range. The decrement of temperature with height when latitude and longitude remain unchanged appears therefore to be 2·77 degrees in 1,000 feet or 1° in 361 feet. In the eastern Himálaya the decrease is more rapid, the observations taken at Darjíling and Gwálpára giving a mean rate of 1° in 320 feet. At great elevations on the table-land, too, it is probable that the temperature diminishes more rapidly than on the southern slope of the mountains. General Cunningham's observations in Spiti and Rúpshu during the month of September, 1847, give a mean increase of about 280 feet in elevation for one degree of fall in temperature; and from the observations taken by Dr. Scully on the return journey from Yárkand over the Karakoram pass and through Ladák in September, 1875, Mr. Blanford has deduced a mean fall of temperature equal to one degree in 227 feet.[1]

The isotherms for equal altitudes in the western Himálaya and Ladák run from about W. 6° N. to E. 6° S., being thus three points less inclined to the parallels of latitude than the general direction of the mountain axis; but in eastern Tibet, Nepál, and Sikkim they probably bend to the southward. The mean temperatures of Káthmandu and Darjíling, at elevations of 4,354 and 6,912 feet above the sea, appear from the observations of ten years to be 61·7 and 53·9 degrees respectively, but according to the preceding formula they should be 66·7° and 60·1°. The mean temperatures of the four stations, Darjíling, Káthmandu, Gwálpára, and Sibságar, in the eastern Himálaya and Asám, may be represented very accurately by the formula $T = 77{\cdot}7^\circ - {\cdot}00312h - 1{\cdot}53\,(\lambda - 26^\circ) - {\cdot}23\,(L - 85^\circ)$. In this part of the chain the temperature decreases at a mean rate of one degree in 321 feet of ascent, and the isotherms run from W. 10° N. to E. 10° S., the direction of the mountain axis being nearly due east and west. The isotherms are thus slightly curved, with the concavity towards the south-west, whilst the general line of the mountains is considerably curved in the opposite direction. This is merely another form of the statement in page 209, that the highest temperatures characterize that part of the chain between the Nepál frontier and the Satlaj.

Supposing the uniform rate of decrease worked out in Table V. to hold good for the whole southern slope of the North-West Himálaya, since the difference of latitude is nearly propotional to that of height, a mean temperature of 49°F., equal to that of London, would be attained at a height of 9,600 feet, and the annual range of temperature would probably differ little from that observed in England. The hill sanitaria, lying between 6,000 and 7,000 feet, possess climates comparable, as regards temperature, to those of Nice, Mentone, and other health resorts in the Riviera; all the towns along the cost of France and Italy from Marseilles to Florence having mean temperatures between 58° and 60°F. The annual range of the monthly means at the Himálayan stations does not exceed 25 or 26 degrees, whereas on the Mediterranean coast it varies from 28 or 29 degrees at Nice to 35 or 36 at Florence and Rome.

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[1] *Indian Meteorological Memoirs*, Vol. I., page 222.

Nice and Ránikhet have exactly the same mean temperature, but Nice is seven or eight degrees hotter than Ránikhet in July and August, and several degrees colder all through the winter and spring months, except in January, when the temperatures of the two places are nearly equal.

At the superior limit of natural forest in the Himálaya, about 12,000 feet above the sea, the mean temperature is probably ten degrees above freezing. In the Alps a species of pine, *P. cembra*, forms natural forests on the borders of perpetual snow, where the mean temperature is several degrees under the freezing point. This difference of habit between the Himálayan and Alpine pines is very curious, and it is difficult to suggest any reason for it, since the natives of the Himálaya and Tibet find little difficulty in growing poplars and fruit trees in sheltered situations up to 13,000 feet or higher.[1] A mean temperature of 32° would be attained at a height of 15,400 feet, which is 2,000 feet above the upper limit of cultivated trees in Tibet.

The zone which has a mean temperature of 32° in any month will probably be near the lower edge of the snows in that month, especially in summer, when the light falls of snow on the outer hills have been all melted away. If the height of this zone be calculated for every month, the highest value obtained will be near the perpetual snow-line. With the uniform rate of decrease given in the last column of Table V., the result for July and August, when the snow line is highest, is about 17,630 feet. This result is very much higher than that given in Humboldt's *Asie Centrale*, on the authority of some of the earliest European travellers who penetrated into the country. General Strachey has, however, shown[2] that some of these mistook the lower limit of glaciers for the line of perpetual snow. The elevations of the snow line on the Trisúl and Nanda Devi groups of peaks, determined by trigonometrical observation from Almora in the latter part of 1848, before the winter snows set in, varied, according to Strachey, from about 17,000 feet on the eastern face of each group to 15,500 on the west; this latter was, however, in part probably newly fallen autumnal snow. The conclusion from these observations was that the height of the snow-line on the "more prominent points of the southern edge of the belt (of snowy mountains) may fairly be reckoned at 16,000 feet at the very least." The Schlagintweits found that the average height of the snow-line on the southern face of the Himálaya from Bhután to Kashmir was 16,200 feet. At page 72 of General Cunningham's book on Ladák the mean height of the snow-line on the peaks north of Simla, determined trigonometrically, is given at 16,665 feet, the highest point observed being about 1,000 feet higher; and in Mr. Drew's volume on the Kashmir territories, published in 1875, the elevation of the snow-line on the outermost zone is stated to be 16,500 feet. The height obtained by calculation as above suggested is thus probably a little too great, though it comes surprisingly close to some of Strachey's observations on Nanda Devi and those of Cunningham on the peaks of Kulu. Some observations have recently been made by the Trigonometrical Survey officers at Mussooree to determine the height of the snow-line on the peaks above Jamnotri, but the results have not yet been published.

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[1] Schlagintweit's *Meteorology of India*, page 565.

[2] *Journal of the Asiatic Society of Bengal*, April, 1849.

For the ranges north of the Indian watershed we have not sufficient data to calculate the approximate height of the snow-line from temperature observations; but the high temperature of Leh and the Spiti valley in July and August show most distinctly that it must be much higher than on the southern side. The limit of perpetual snow on the ridges bordering on Tibet, especially those which lie beyond the Satlaj, is given by Strachey as 19,000 feet at least. Dr. Gerard many years ago, and more recently Mr. Drew, assigned an elevation of 20,000 feet to the limit of the snow in Rúpshu. One reason why this limit is so high—the intensity of solar radiation in summer—has already been mentioned; another is the insignificant quantity of snow that falls each winter in these regions that are almost completely cut off from the great southern vapour currents.

The lower limit of the snow in winter is usually about 6,500 feet in Kumaon and somewhat lower in Dehra Dún and the hills north of the Panjáb. While it lies the temperature does not rise much above 32°, but it seldom falls in sufficient quantity to lie more than a few days at a time. About one year in ten the snow comes down as low as 5,000 feet. The lowest level attained in the first half of the present century was about 3,000 feet in 1817 and 1847. In 1877 and 1878, though the snowfall was heavier than it had been for many years, it did not come down much below 5,000 feet. A slight fall of snow is said to have been observed at Lahore on the 12th of January, 1874,[1] but no notice of this unprecedented occurrence was taken in the meteorological report for that month.

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[1] *Pioneer*, 17th January, 1874.

Atmospheric pressure and winds.

One of the most important effects of solar heat upon the atmosphere is the disturbance of its statical pressure relations, which in turn gives rise to those movements of adjustment towards equilibrium that are recognised as winds. The diurnal heating and cooling of the air causes certain oscillatory variations of pressure called the barometric tides, and gives rise to wind movements, such as the land and sea breezes and certain mountain winds that will be described below. The great annual change of temperature between summer and winter, in like manner, causes an annual variation in the height of the barometer and sets up those great currents of the lower atmosphere that are called the monsoons. Since the temperature is constantly changing no such thing as a simple statical distribution of pressure ever exists, though the averages of long series of observations may approximate more or less nearly to what a statical distribution would be. The air is constantly in motion either horizontally or vertically, and these movements cause variations of pressure, just as variations of pressure produce movements. Cause and effect, as regards pressure variations and winds, are thus so inextricably mixed up that it is next to impossible to disentangle them and show their relations clearly.

There can be little doubt that both the daily and the yearly inequality of pressure grow less as we ascend; and the annual variation at least becomes quite altered in character at a moderate elevation; but since the barometric variations depend upon the range of temperature which is possibly very great at great altitudes, while at a height of 6,000 or 7,000 feet it is less than on the plains, the decrease of the pressure variations with height is not strictly proportional to that of the total pressure. Table VI. gives the mean monthly pressures at a number of stations, and Table VII. the average daily range between 9-30 or 10 A.M. and 3-30 or 4 P.M. The figures for Bareilly, Roorkee, Dehra, Mussooree (both stations), Ránikhet, Chakráta, and Leh, have been corrected for the index errors of the barometers and are thus comparable with each other, except in so far as the different lengths of the periods of observation may cause the averages to differ; the others involve an unknown barometer error, which does not, however, affect the range of pressure, either diurnal or annual.

VI.—Monthly and annual means of Pressure at places in the Himálaya.

Place.	Elevation in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December	Year.	Number of years.
		"	"	"	"	"	"	"	"	"	"	"	"	"	
Bareilly ...	568	29·417	29·366	29·263	29·148	29·003	28·924	28·931	29·002	29·097	29·268	29·393	29·489	29·187	11—12
Roorkee ...	887	29·123	29·057	28·967	28·856	28·744	28·615	28·629	28·694	28·796	28·959	29·090	29·182	28·888	12
Dehra ...	2,232	27·734	27·689	27·632	27·558	27·468	27·346	27·348	27·403	27·495	27·638	27·740	27·763	27·567	12
Dharmsála ...	4,495	25·478	25·449	25·442	25·429	25·361	25·318	25·296	25·323	25·465	25·545	25·624	25·620	25·446	2
Almora[1] ...	5,546	24·704	24·622	24·668	24·588	24·542	24·422	24·434	24·462	24·678	24·710	24·771	24·731	24·603	1
Mussooree (1),	5,855	24·287	24·284	24·304	24·250	24·211	24·123	24·104	24·143	24·217	24·290	24·321	24·323	24·236	1—3
Ránikhet ...	6,069	24·096	24·076	24·070	24·066	24·010	23·933	23·926	23·959	24·023	24·106	24·157	24·134	24·046	5—7
Naini Tál ...	6,463	23·865	23·834	23·858	23 832	23·760	23·687	23·693	23·716	23·758	23·879	23·905	23·894	23·807	5
Mussooree (2),	6,881	...	...	...	...	23·334	23·267	23·249	23·294	23·358	23·439	23·492	23·423	...	1—14
Chakráta ...	7,052	23·259	23·220	23·243	23·238	23·194	23·183	23·113	23·158	23·223	23·298	23·308	23·287	23·222	4—5
Leh ...	11,508	19·604	19·578	19·640	19·649	19·668	19·650	19·616	19·640	19·692	19·722	19·742	19·701	19·659	4—6

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[1] From one year's observations by General Strachey.

VII.—Mean diurnal and annual ranges of pressure at places in the Himálaya.

Place.	Diurnal range, 10 a. m. to 4 p. m.													Annual range of monthly means.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	
	″	″	″	″	″	″	″	″	″	″	″	″	″	″
Bareilly	·105	·104	·107	·118	·119	·112	·096	·097	·107	·103	·108	·108	·107	·515
Roorkee	·093	·088	·089	·099	·097	·106	·083	·088	·099	·094	·091	·095	·093	·517
Dehra	·087	·087	·082	·090	·090	·086	·070	·076	·092	·092	·093	·089	·086	·417
Almora	·090	·090	·090	·090	·080	·090	·080	·080	·090	·100	·090	·100	·090	·349
Mussooree (1)	·047	·050	·041	·038	·052	·063	·045	·057	·060	·047	·042	·078	·051	·219
Ránikhet	·068	·064	·056	·060	·056	·052	·052	·055	·058	·062	·065	·060	·059	·231
Naini Tál	·066	·063	·066	·053	·054	·045	·042	·049	·058	·060	·057	·058	·055	·212
Mussooree (2)	...	...	...	...	·034	·037	·040	·044	·053	·054	·046	·049	...	...
Chakráta	·051	·050	·050	·048	·040	·039	·051	·047	·051	·056	·053	·050	·049	·190
Leh	·081	·079	·074	·057	·080	·071	·070	·083	·096	·079	·089	·082	·078	·126 ·164

The double barometric tide that occurs regularly every day, especially in tropical countries, is still one of the least understood of atmospheric phenomena. It has been observed at all elevations in the Himálaya to which barometers have been carried, and with no considerable difference of phase,[1] though the range and general form of the oscillation are not the same at different heights. It is thus probably something of the nature of a wave of expansion and contraction propagated upwards and downwards with a velocity equal to that of sound.

The amplitude of the daily tide bears an obvious relation to the diurnal range of temperature, for it is greater over land areas than over the sea, and in table VII. it is seen to decrease pretty regularly from the plains up to stations situated at an elevation of 6,000 or 7,000 feet, where the range of temperature is least, becoming greater again at Leh, where the temperature range is large. Moreover, on the plains there is a well-marked annual variation of the daily range of the barometer, having its maximum in the hot-weather months, when the temperature range is greatest, and its minimum in the rainy season. But the inequality of temperature is not the only cause on which the observed barometric tides depend; for their amplitude, as well as their general form, varies with the season, the latitude and the position of the place with respect to the sea and to mountain ranges.

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[1] Professor Loomis, in the *American Journal of Science* for 1879, finds that at the top of Mount Washington the daily maxima and minima set in three hours later than at the foot, though the difference of elevation between the two stations is only a little over 3,000 feet. This is quite unlike anything that occurs in the Himálaya, and is doubtless due to other causes than those which produce the diurnal tides. Hourly observations made in India show that up to a certain moderate elevation the daily barometric maxima and minima are slightly retarded; but this is due to the mountain winds described below. At Leh, in the upper Indus valley, the diurnal winds cause the morning maximum to occur nearly an hour earlier than on the plains. This will be seen from the following table :—

Place.	Height.	Morning maximum.	Afternoon minimum.
	Feet.	H. M.	H. M.
Calcutta	18	9 35	16 26
Allahabad	307	9 31	16 30
Hazáribágh	2,010	9 47	16 21
Simla	7,071	10 26	16 51
Leh	11,503	8 48	16 29

The observed diurnal movements of the barometric column are in fact made up of several parts, only one of which is directly caused by the alternate heating and cooling which the air undergoes every day, though the others are all indirect effects of it. The direct effect of heating and cooling upon the pressure of the air has been more or less clearly explained by Espy, Davies, and Kreil, but it has not yet been shown by strict mathematical reasoning that their explanation accounts for the whole of the phenomenon. There is firstly, with a rise of temperature in the morning, an increase in the elastic force of the air, indicated by a rise of the barometer. But the increased elastic force immediately sets up a movement of expansion, either vertically or it may be in some cases laterally, by which the pressure is diminished. The actual movement of the mercury in the barometer is determined by the difference of these two actions; and consists of a rise at first, up to 9 or 10 A.M., on the average, followed by a fall which goes on until some time after the hottest period of the day. It is easily seen that as long as the temperature continues to rise more and more rapidly, that is up to 9 A.M. or a little after, the first effect must outweigh the second, and the barometer will rise; but as soon as the rate of increase of temperature begins to grow less, expansion will prevail and the barometer will fall. The expansion will not cease at the instant when the temperature reaches its maximum, but owing to the accumulation of motion it will go on for some time longer. Thus, there ought to be a barometric maximum about the time of most rapidly increasing temperature and a minimum in the afternoon. In much the same way it can be shown that there should be a maximum in the evening, when the temperature is falling most rapidly, and a minimum about the coldest time of the morning.

The coincidence between the barometric minima and the extremes of temperature is usually very far from exact, the barometer in this country standing lowest in the mornings about two hours before the time of minimum temperature, and in the afternoon about an hour and a half or two hours after the hottest time of the day. This may perhaps be explained on the principle of forced oscillations, that in the successive transformations which the energy undergoes, the oscillations approximate more and more nearly to simple harmonic waves with the maxima and minima separated by equal intervals. The diurnal curve of temperature approaches more nearly to a simple wave form than that of the solar radiation which falls upon the earth at any place, and the double daily oscillation of pressure can be almost exactly represented by two waves superimposed.

At most places in India and the Himálaya the minimum temperature of the day occurs about sunrise, that is at 6 A.M. on the average of the year, and the maximum is attained about 2 P.M. The daily rise of temperature therefore occupies only eight hours of the twenty-four, and the fall the remaining sixteen. On the principle that the height of the barometer varies with the rate of change of temperature, the morning maximum should be much more decided than that of the evening; and this is found by observation to be the fact, especially in the interior of India and other continental countries. Over the sea in tropical regions the periods of increasing and decreasing temperature are probably more nearly equal, and there the difference between the day and night waves of pressure is less.

At places near the equator the epochs of maximum and minimum pressure hardly vary from month to month; but in higher latitudes the morning maximum and afternoon minimum approach each other when the days are short, and become more widely separated in the long days of summer.

Besides this primary oscillation of pressure caused by the heating and cooling of the air every day, the barometer indicates other changes due to the transfer of air by winds blowing to and from the place of observation, and perhaps also in some places it indicates other changes again due to the repetition of previous oscillations in the form of free waves.. The great regularity and considerable range of the barometric tides over tropical seas where the daily range of temperature is small, may be thus to some extent caused by the repetition of the waves of previous days. In high latitudes, where the days and nights are usually of very unequal length and the variation of temperature is irregular, the tides become feebler, and near the pole disappear altogether, for in forced vibrations of any kind regular periodicity in the cause is an essential condition.

Near the coast the land and sea breezes modify the form of the diurnal pressure curves both at sea and on land. The transfer of air from sea to land during the earlier hours of the night renders the nocturnal fall of pressure on land less, and at sea greater, than it would otherwise be, while the land breeze which blows in the forenoons has a similar effect in the opposite direction. Over the water the morning minimum thus comes to be the lower of the two, in opposition to the usual rule.[1] Among the mountains a very similar semi-diurnal transference of air takes place, causing two distinct types of barometric tides—the one characteristic of valleys and the plains near the mountain system, and the other of high ridges and detached peaks. These types can be readily distinguished in the following table, which gives the variations from the daily mean at the hours nearest the turning points of the tides :—

	4 A. M.	10 A. M.	4 P. M.	10 P. M.
Bareilly ...	—·021	+·060	—·047	+·008
Roorkee ...	—·020	+·057	—·036	—·001
Ránikhet ...	—·025	+·041	—·018	+·013
Naini Tál ...	—·028	+·043	—·012	—·003
Chakráta ...	—·022	+·035	—·015	—·001
Simla[2] ...	—·047	+·063	—·032	+·022
Leh ...	+·011	+·037	—·049	+·001

At Bareilly and Roorkee, on the plains, the variation from the mean at 4 P. M. is twice as great as at 4 A. M. At all the Himálayan stations except Leh, which is in a valley between two ridges, this relation is reversed. Over the plains and on the outer hills, as at Naini Tál and Chakráta, the pressure at 10 P. M. hardly differs from the mean of the day. There is a small positive variation for this hour at Bareilly, and as we recede from the mountains and approach the sea the variation becomes greater ; but there can be little error in concluding from the above table that along the southern border of the Himálaya the pressure rises in the evening just sufficiently to touch the mean. At Simla and Ránikhet, some twenty or thirty miles in towards the centre of the mountain system, there is, however, a well-marked evening maximum. This seems to indicate that the air continues to accumulate over the interior of the mountain zone for some time after the current has changed on the outer ranges and the air has commenced to flow back towards the plains.

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[1] Blanford, J. A. S. B., Vol. XLVI., Part II., page 45.

[2] From General Boileau's observations in 1843-45. The daily range given by these figures is nearly twice as great as that of the other stations at the same altitude. The reason is probably some difference in the form of the barometer or in the mode of applying the correction for capillarity.

The transfer of air from the plains to the mountains in the daytime and its retransfer to the plains at night, which, by partly counterbalancing the afternoon fall of the barometer in the mountains and correspondingly increasing it on the plains, cause the peculiarities of the pressure variations seen in the preceding table, are brought about by the expansion and contraction of the air under the influence of heat and cold. In the daytime the air over the plains expands more than that over the hills, because the total thickness of air is greater and the range of temperature is probably higher. The surfaces of equal pressure, which we may assume to be horizontal on the average, are thus raised more above the plains than on the mountains, and the air under the influence of gravity flows down the incline towards the mountains. At night the air contracts and these surfaces sink more above the open plains than in the hills, and there is thus a slope or gradient in the opposite direction.

The following is General Strachey's description of the diurnal variation of the wind in Kumaon :—

"At most seasons of the year we find that on the Himálayan slope winds blow up the valleys during the day, that is from about 9 A. M. to 9 P. M., and down them during the corresponding hours of the night, or from 9 P. M. to 9 A. M. At the debouches of the principal streams into the plains, these night winds blow downwards with great violence, particularly in winter. In the interior of the mountains they are more moderate ; and at great elevations, and in the central parts of Tibet, the nights are almost always nearly calm. The diurnal currents from the south, on the other hand, increase in force as we ascend in height ; and along the Indian watershed and the neighbouring parts of Tibet they are excessively strong ; so that in travelling there, I have often looked forward to the afternoon, when they are at their height, with real dread ; and the natives of the country invariably endeavour to cross the high passes of the Indian watershed early in the day, for the purpose of avoiding the fury of the afternoon wind. As we advance further into the tableland, however, their power rapidly ceases.

"These winds, though on the whole blowing from the south-west during the day and from the north-east at night, that is perpendicular to the general line of the mountains, are naturally constrained to follow the course of the deep valleys up which they pass, so that their direction is subject to endless local variation ; and, excepting on the tops of the hills, little information can be obtained by a register of the direction of the wind on the Himálaya, beyond the fact of there being an up or down current. In the part of Tibet I visited, near the Indian watershed to the north of Kumaon, the day wind seemed to commence in the south-east quarter about 9 A. M., and gradually to shift round with the sun as the day advanced, ending in the south-west quarter about 9 P. M. On several occasions in these localities I also noticed the wind blowing faintly from the north early in the morning. * * * * * * * * * *

"The calm nights of the table-land and the higher mountains would (according to the theory above stated) be a consequence of their position in the centre of the mountain area, where the down current would originate, and therefore have the least force, though it be still felt in the faint northerly winds that are often observed near the Indian watershed.

"The violent night winds from the gorges by which the principal rivers leave the mountains would not appear to be altogether due to the same cause which produces the ordinary down winds, but to the accumulation of cold air in the deeper valleys to which I have before alluded. The air collected in these aërial lakes, as they may be called, having no means of escape but the openings through which the drainage is carried off, pours from them in a current the velocity of which will be dependent on the depth and area of the mountain basin from which it flows."

General Cunningham also states that in Ladák and Spiti the southerly or south-westerly day wind usually begins about 9 A. M., the wind blowing faintly from the north about midnight and from the north-east in the early morning.

The day and night winds are probably strongest about 4 P. M. and 4 A. M., and the pressure and temperature observations made at these hours on the plains and at the hill stations indicate clearly enough that the direction of the baric gradient is from the plains towards the mountains in the afternoons, and from the mountains towards the plains in the mornings. When the pressures of Roorkee and Bareilly at 4 A. M. are reduced to the level of Chakráta and

Ránikhet respectively, and are corrected for any residual gradient to or from the mountains discovered by similarly reducing the mean pressures to the level of the hill stations, it is found that there is a pressure difference of ·077″ at Chakráta and ·055″ at Ránikhet, sending a wind towards the plains. At 4 P. M. the gradient is towards the hills, and is equal to ·062″ at an elevation of 7,000 feet between Roorkee and Chakráta; while between Bareilly and Ránikhet it is equal to ·045″ on the average of the year. On the southern border of the mountain zone the gradient causing the down wind at night is therefore rather greater than that which causes the up wind during the day.

When the pressures of Roorkee at 4 A. M. and 4 P. M. are reduced to the level of Leh, a station beyond the Indian watershed, the gradients are found to be ·033″ in the morning and ·182″ in the afternoon. The pressure difference causing the day wind at great elevations thus appears to be nearly six times as great as that which causes the night wind; but this relation is much exaggerated, no doubt, by the peculiar form of the pressure variation at Leh, which cannot be taken as a typical mountain station. This peculiar variation is doubtless due to the position of Leh in a narrow valley between two parallel mountain ranges. In the daytime the air of the valley expands and flows towards the mountains, and at night it again accumulates over the valley. In this way the nocturnal barometric tide is completely obliterated, and the afternoon fall of the barometer is rendered much greater than it would be on an open plain at the same altitude.

In April, May, and June the afternoon winds of the mountains blow with greatest violence, because in these months the range of temperature both on the plains and among the mountains is greatest. In these three months we find the afternoon fall of the barometer on the plains at a maximum, while at the hill stations it is less than in the cold weather. The nocturnal inequality of pressure is then at a minimum on the plains and valleys and at a maximum on the hills.

The annual variation of pressure differs from the diurnal in that no part, or an exceedingly minute part, of it is due to direct increase or decrease of elastic force accompanying gain or loss of heat. The rise of temperature in the first half of the year and the fall in the latter half are accomplished so slowly that the increase or decrease of elastic force cannot accumulate, but is lost in expansion or contraction. The annual variation is thus almost entirely a secondary effect due to the movement of air both vertically and horizontally. When the temperature of the air over India changes the air expands or contracts, and the hypothetical surfaces of equal pressure widen out or come closer together than they were before; and since the annual variation of temperature over the south of India is very small in comparison with that which occurs over the northern plain and in Central Asia, the vertical range through which these surfaces travel in the course of a year will be greater on the Himálaya than under the equator. In the cold weather, for example, the planes of 30, 29, 28, &c. inches are wider apart vertically over Ceylon than in Northern India, while at the end of the hot and in the rainy season the opposite relation obtains.

If there were no lateral movements of the air the pressure at a station on the plains would be nearly constant all the year round, while at the hill stations it would be least in winter and greatest in summer, because in the latter season a larger fraction of the total atmosphere than usual would be elevated above the place, while in the winter less than usual would lie above it. In winter, however, the planes of equal pressure in the upper regions of the atmosphere over India all slope towards the north, and down this slope winds blow, causing an accumulation of air over Northern India which renders the total pressure observed on the plains at that season greater than in summer. As regards mountain stations, it depends entirely on the height of the place whether the influx of air from the south will be more or less than sufficient to compensate for the contraction and sinking of the atmosphere in winter. At all the hill stations in Table VI. above 5,000 feet elevation there are indications of a winter minimum of pressure, though this is not the lowest minimum except at Leh, the most elevated station of all. There the pressure is least in the beginning of February, whereas at all the other stations, as on the plains, it is least in June and July.

During the cold weather winds are usually blowing out from Northern India towards the south along the surface of the ground at the same time that other currents are blowing northward in the upper strata; the apparent direction being modified in either case by the rotation of the earth on its axis and by friction against the ground surface. On the plain of the Ganges the conformation of the surface makes the lower winds have a north-westerly direction.

As the temperature rises the air over India expands and a larger and larger proportion of the total atmosphere is lifted above the level of the hill stations. In consequence of this the barometer at first rises at the higher hill stations; and it simultaneously sinks over the plains and the lower hills owing to the outward movement of the air. As the season advances more and more air is removed from India by the strong day winds which blow in the hot weather as well as by the winds over the Indian watershed that have been already described, while but little is restored by the feeble night winds that come from the opposite quarters; the barometer continues to fall over the plains, and the rise observed at the hill stations in spring is soon also changed to a fall, except at Leh, where the barometer continues rising until May. In the upper half of the atmosphere, that is, above the plane of 15 inches pressure, the summer depression of the barometer, which at Leh is feebler than that of winter, probably disappears altogether, and the barometer stands highest in the hottest season as it would do at all elevations if there was no transfer of air from place to place by lateral currents or winds.

When the temperature of Northern India is at its maximum in the latter half of June, the planes of equal pressure are widest apart, and they all slope towards the north in the lower half of the atmosphere. Winds consequently blow in from the sea towards the land in the lower strata, and there are possibly upper currents in the opposite direction, though the existence of such has not yet been established. This relation continues until the autumnal equinox, after which the temperature falls rapidly, and the atmosphere contracts and sinks so as to reproduce the conditions characteristic of the cold weather. The cooling of the air at this season, like the heating of it in spring, produces a differential effect on the height of the barometer at the hill stations, which again have a maximum of pressure in November.

When the effects of the two actions above described—the expansion and contraction of the atmosphere vertically, and the lateral transference of air by winds—are borne in mind, some curious and at first sight inexplicable peculiarities of the annual variation of pressure become intelligible. For example, on the plains the barometer almost invariably stands higher in December than in January, though January is the colder month of the two. This anomaly at once disappears when we remember that the total pressure of the air on the plains, considered statically, is made up of two parts—that of the air from the plains up to the hill stations, and that of the air lying above the hill stations. The latter part appears from the observations of Leh to be greatest in the first fortnights of May and November, and least in the corresponding parts of February and August; and if the monthly means for any station on the plains or lower hills be subjected to harmonic analysis, the annual variation will be found to be very closely represented by two harmonic waves—one of annual period, reaching its maximum at the time of greatest cold in the beginning of January, and the other of six months' duration nearly coinciding in phase with the pressure variation at Leh. The amplitude of the first of these undulations, which is as much as six tenths of an inch at some places on the plains, rapidly diminishes as we ascend, and passing through a zero value at about 10,000 feet elevation, re-appears at Leh in nearly the opposite phase, the minimum falling in winter. The amplitude of the half-yearly oscillation increases slightly as we ascend, but it appears to vary with distance from the plains in a horizontal direction rather than with height. The observed pressure on the plains, being due to the superposition of the two waves, is highest in December—that is, between the dates when each wave separately attains its maximum.

The truth of this theory of the annual change of pressure may be more clearly seen from Table VIII., where the monthly variations of the barometric weights of three successive strata of the lower atmosphere from their annual mean values are compared with the simultaneous variations of temperature. The last double column gives the variations for the whole thickness of the atmosphere from the plains up to 11,500 feet above sea-level.

VIII.—Annual variation of pressure and temperature in the lower atmospheric strata over the Himálaya.

Month.	*Roorkee to Dehra,* 1,345 *feet.*		*Dehra to Chakráta,* 4,820 *feet.*		*Chakráta to Leh,* 4,451 *feet.*		*Roorkee to Leh,* 10,616 *feet.*	
	Temperature variation.	Pressure variation.	Temperature variation.	Pressure variation.	Temperature variation.	Pressure variation.	Temperature variation.[1]	Pressure variation.
	°	″	°	″	°	″	°	″
January	−17·0	+·067	−15·3	+·131	−18·2	+·092	−18·2	+·290
February	−13·2	+·046	−12·6	+·125	−14·9	+·079	−14·5	+·250
March	− 4·6	+·014	− 5·3	+·045	− 7·5	+·040	− 6·4	+·099
April	+ 6·0	−·018	+ 4·4	−·029	+ 2·1	+·026	+ 3·6	−·021
May	+12·3	−·040	+ 9·9	−·075	+ 7·3	−·037	+ 9·6	−·156
June	+14·9	−·052	+13·0	−·131	+13·0	−·080	+14·0	−·263
July	+10·0	−·040	+ 8·9	−·119	+14·7	−·066	+13·3	−·225
August	+ 8·8	−·030	+ 8·2	−·099	+13·0	−·045	+11·7	−·174
September	+ 7·3	−·020	+ 6·7	−·073	+ 8·7	−·032	+ 8·4	−·123
October	+ 0·2	−·001	+ 0·5	·000	− 0·1	+·008	+ 0·2	+·007
November	− 9·0	+·029	− 6·1	+·092	− 6·4	−·001	− 7·5	+·120
December	−15·9	+·048	−12·0	+·131	−11·3	+·023	−14·0	+·202

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[1] From the average of the three stations—Roorkee, Chakráta, and Leh.

The barometric weight of each stratum and of the whole thickness—that is, the difference between the observed pressures at the top and bottom—varies inversely with the temperature, and the one variation is as nearly as possible proportional to the other. The only exception worth noting is that in the month of November the statical pressure of the stratum between Chakráta and Leh is less than it should be according to the temperature figures. This anomaly, however, would probably disappear from the means of a longer series of observations.

The annual variation of the wind in Northern India is for the most part such as should accompany the pressure variations above described, according to the usually received "convection current" theory ; but there is one important feature of the winds of the plain that has not yet been satisfactorily explained—namely, the prevalence during the hot weather of strong north-westerly winds when the distribution of temperature and pressure should, by the theory of convection currents, give rise to winds with a southerly element These "winds of elastic expansion," as they have been called by Mr Blanford, actually blow sometimes from places where the mean pressure is low to others where it is slightly higher. They are the strongest winds of the year on the Indian plain ; they blow only in the daytime, and since there is no compensating current of any appreciable strength at night, they are probably the chief agency in that removal of air from Upper India which causes the great summer depression of the barometer. They are not confined to India, but are equally characteristic of Afghanistan ; and Colonel Prejevalsky encountered winds perfectly similar in everything except temperature in various parts of the Gobi desert and on the Alashán plateau north-east of Tibet. On the southern slope of the Himálaya these winds are sometimes met up to elevations of 6,000 or 7,000 feet, and when they blow the air is unusually dry and full of dust. At greater elevations, however, they are either not felt or become undistinguishable from the ordinary up currents that blow during the day.

IX.—Mean resultant wind directions at places in the Himálaya.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Number of years.
Bareilly ...	N.57°W.	N.54°W.	N.56°W.	N.56°W.	N.82°W.	N.85°E.	S.66°E.	S.64°E.	N.81°E.	N.62°W.	N.54°W.	N.65°W.	9-12
Roorkee ...	N.71°W.	N.51°W.	N.76°W.	N.78°W.	S.21°W.	S 6°E.	S.40°E.	S.34°E.	S.	S.30°E.	S.18°E.	N.74°W.	10-13
Dehra ...	S.72°W.	S.67°W.	S.79°W.	S.74°W.	S.58°W.	S.66°W.	S.67°W.	S.56°W.	N.61°W.	N.64°W.	N.78°W.	N.89°W.	9-10
Dharmsála ...	S.71°W.	S.73°W.	S.80°W.	S.69°W.	S.59°W.	S.66°W.	S.71°W.	S.71°W.	S.57°W.	S.66°W.	S.52°W.	S.59°W.	4-5
Ránikhet ...	S.81°W.	S.54°W.	S.57°W.	S.63° W.	S.63°W.	S.75°W.	S.77°W.	S.72°W.	S.61°W.	S.53°W.	S.56°W.	S.60°W.	7-10
Naini Tál ...	S.49°E.	S.39°E.	S.	S.57°E.	S.49°E.	S.40°E.	S.41°E.	S.44°E.	S.44°E.	S.41°E.	S.38°E.	S.41°E.	7
Chakráta ...	S.69°W.	S.19°E.	S.	S.59°W.	S.55°W.	S.74°W.	S.51°W.	S.55°W.	S.50°W.	S.28°W.	S.29°W.	S.18°W.	6-10
Leh ...	S. 8°W.	S.11°W.	S.28°W.	S.22°W.	S.40°W.	S.52°W.	S.57°W.	S.55°W.	S.29°W.	S. 37°W.	S.27°W.	S.17°W.	4

From the preceding table it is seen that though the change of the prevailing wind from north-west to east or south-east at the commencement of the rains is very distinctly marked on the plains, no such change takes place at the hill stations. Even at the lowest of these, Dehra, the resultant wind varies only from about three points north to the same distance south of west. At all the higher stations the prevailing direction in every month is southerly or south-westerly, with modifications depending on the form of the ground,—at Naini Tál, for instance, the winds are generally south-easterly. The only notable variation of the wind direction is a deflection towards the east at Chakráta (also at Simla, Marri, and other stations on the north-western Himálaya) at the time when the winter snows and rains are heaviest. The cause of this has not yet been ascertained.

The wind direction at the hill stations changes so little from month to month because the winter monsoon is of no great vertical thickness, while that of the summer months extends to a much greater elevation than the highest station at which observations have been made. When northerly or north-westerly winds are blowing on the plains, the return current from the south-west is felt on the mountains at all elevations above the first few thousand feet; and when southerly winds blow over the plains, the return current, if it exists at all, lies at a very great altitude. The existence of this return current from the north during the summer monsoon may possibly be proved by cloud observations. Dr. Scully's observations on the way back from Yarkand in August, 1875, tell neither for nor against it, the resultant of all the wind directions observed at elevations above 14,000 feet being due west.

In the next table the vertical thickness of each monsoon current on the Himálayan slope has been computed approximately from observations made at pairs of hill stations in the north and south of India. The northern stations are Rookee and Chakráta, and the southern ones, Colombo and Newara Eliya in Ceylon. To render the figures directly comparable, the observed pressures at the hill stations have been reduced to the common elevation of 7,000 feet, and those of the lower stations to sea-level, as was done by Mr. Blanford in drawing up a similar table in the *Indian Meteorologist's Vade Mecum*, page 175.

X.—*Vertical thickness of the Monsoon Currents.*

Season.	Month.	Mean pressure at 7,000 feet.			Mean pressure at sea-level.			Neutral plane.	
		Ceylon.	Debra Dún.	Gradient sending wind towards north.	Ceylon.	Debra Dún.	Gradient sending wind towards north.	Approximate pressure.	Approximate elevation in feet.
		"	"	"	"	"	"	"	
Winter.	November ...	23·388	23·353	+ ·035	29·904	30·021	− ·117	24·45	5,780
	December ...	23·387	23·337	+ ·050	29·911	30·078	− ·167	24·89	5,260
	January ...	23·379	23·310	+ ·069	29·915	30·070	—·155	25·39	4,690
	February ...	23·389	23·270	+ 119	29·917	29·994	− ·077	27·35	2,650
Summer.	June ...	23·348	23·179	+ 169	29·856	29·483	+ ·373	17·96	14,130
	July ...	23·343	23·160	+ ·183	29·874	29·508	+ ·366	16·81	15,930
	August ...	23·344	23·205	+ ·139	29·879	29·576	+ ·303	17·80	14,370
	September ...	23·359	23·270	+ ·089	29·897	29·684	+ ·213	18·67	13,140

At 7,000 feet elevation the pressure gradient in both seasons is such as to send a current from south to north, while at sea-level it is only in the winter season that the wind blows from north to south. The neutral plane separating the lower wind current from the supposed upper return current is nearly 16,000 feet above the sea in the height of the rainy season; but in the cold weather, especially in January and February, the neutral plane is below the level of the hill sanitaria.

The heights in the table represent only the approximate mean positions of the neutral plane for the several months. In reality its height is constantly fluctuating, and thus in the winter season it often sinks so low as to strike the Indian plain below the base of the hills. A moist easterly or south-easterly current then blows for several days at a time in Upper India, bringing the winter rains, while in Southern India the wind may be northerly. The *prevailing* direction of the wind on the plains is, however, always northerly in the cold weather, in accordance with the mean position of the neutral plane.

The pressure gradients both at sea-level and at 7,000 feet are much greater in summer than in winter. In the latter half of October and the beginning of November there is hardly any gradient either way, and at that time feeble winds and calms prevail. The velocity of the wind being directly proportional to the baric gradient (except perhaps in the case of anomalous currents like the "winds of elastic expansion" which blow down the valley of the Ganges in the hot weather), this velocity should be greater in the rainy season than in winter.

XI.—Monthly mean velocity of wind in miles per diem.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Roorkee,	55·8	65·9	67·3	74·6	91·9	101·0	18·3	65·5	58·8	35·3	31·3	35·7	63·5
Bareilly,	70·6	95·4	95·1	110·4	117·2	134·5	105·5	75·9	71·6	41·0	42·3	51·6	84·3
Dehra ...	40·1	49·2	57·6	65·2	64·7	54·0	34·9	29·6	34·1	42·6	50·9	47·4	47·3
Ránikhet,	71·9	77·0	87·1	131·3	98·0	120·0	129·1	150·3	136·4	116·6	99·5	95·0	109·4
Chakráta,	114·5	114·6	129·4	137·0	135·8	128·1	110·1	88·5	100·3	116·1	105·9	103·3	117·7

Table XI. shows that on the plains and at Ránikhet (for which station more observations are required to get a good average) the wind velocity is least in winter, but that at Chakráta it is least in the rains. At the hill stations the winds are chiefly of the diurnal kind, and are feeblest when the temperature range is least—that is, in the month of August.

Humidity and cloud.

The quantity of water vapour present in the air at any time is a most important meteorological condition. It depends on the temperature, the distance from the sea or other evaporating surface, and the direction of the wind. These relations are very distinctly marked on the North Indian plain, where the high temperature range in the yearly period and the semi-annual change of the winds combine to render the proportion of vapour in the air during July and August nearly three times as great as in December and January. A high temperature cannot of course increase the quantity of vapour in the air, unless it be in a region where vapour is being generated. Accordingly we find in Table XII. that the vapour pressure at Roorkee, on the drier part of the plain, hardly varies from December to April, though as soon as the sea winds set in, which they sometimes do in the middle of May, the proportion of vapour rapidly increases. At Bareilly, where the surrounding country is moister and better wooded than at Roorkee, there is a slight increase of vapour in the hot-weather months.

XII.—*Monthly mean tension of aqueous vapour at places in the Himálaya.*[1]

Place.	Elevation in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		″	″	″	″	″	″	″	″	″	″	″	″	″	
Bareilly	568	·334	·353	·413	·456	·570	·751	·953	·939	·866	·610	·422	·351	·585	11-12
Roorkee	887	·310	·338	·362	·360	·460	·677	·902	·903	·820	·543	·368	·324	·531	12-13
Dehra	2,232	·294	·325	·372	·418	·511	·721	·881	·878	·794	·521	·356	·301	·531	12-13
Dharmsála	4,495	·271	·281	·352	·439	·459	·539	·643	·627	·601	·444	·294	·274	·436	4-5
Mussooree	5,850	·202	·206	·249	·280	·322	·471	·643	·620	·621	·402	·281	·240	·378	1-3
Ránikhet	6,069	·190	·203	·235	·264	·341	·472	·597	·598	·536	·354	·253	·199	·353	6-7
Chakráta	7,052	·177	·191	·222	·265	·332	·455	·583	·582	·519	·344	·226	·187	·340	8-11
Kumaon and Garhwál[2],	8,000 to 9,000	...	·140	·220	...	...	·400	...	...	...	·280	...	...	?	...
Ditto	9,000 to 10,000	...	...	...	...	...	·420		...	...	·250	...	...	?	...
Ditto	10,000 to 11,000	...	...	...	...	...	·310	·350	...	...	·330	...	...	?	...
Leh	11,538	·103	·120	·134	·142	·167	·217	·339	·313	·246	·144	·115	·093	·177	4
Kumaon and Garhwál[2],	12,000 to 13,000	...	...	...	...	...	·210	·250	·320	...	...	...	...	?	...
Ditto	13,000 to 14,000	...	...	...	...	...	...	·200	...	...	...	...	...	?	...
Ditto	14,000 to 15,000	...	...	...	...	...	...	·140	·210	·200	·120	...	...	?	...
Ditto	15,000 to 16,000	...	...	...	...	...	...	·140	·130	·110	...	...	...	?	...
Ditto	16,000 to 17,000	...	...	...	...	...	...	·120	·180	...	...	...	...	?	...
Ditto	17,000 to 18,000	...	...	...	...	...	...	·130	...	...	...	...	...	?	...
Ditto	18,000 to 19,000	...	...	...	...	...	...	·120	·150	...	...	...	...	?	...

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[1] These are the means of observations at 10 A. M. and 4 P. M. There is a certain diurnal variation of vapour tension, but its range is very small and it varies a good deal at different places. For most of the stations in the table the correction for this variation is unknown, and therefore all the figures have been given uncorrected.

[2] From miscellaneous observations by General Strachey.

The tensions in the foregoing table have been computed from observations of dry and wet bulb thermometers. The formula used for the most part has been Apjohn's; but all the figures for Leh and Musooree, and those for the last four years at the other stations, have been computed by means of certain tables based on August's formula.

On the southern slope of the mountains the annual variation of vapour tension is similar to that which obtains on the plains, though because of the considerable evaporation from the forest-covered slopes, and the occasional showers of rain which fall, the increase of vapour during the hot weather goes on much more uniformly than on the plains. At Leh, where hardly any precipitation occurs at any time of the year, but in the neighbourhood of which there is some cultivated land irrigated from the hill streams, the annual variation of vapour tension is determined almost entirely by the temperature. In the valley of Yárkand the quantity of vapour in the air is similarly determined by the temperature and the extent of irrigation.

In the mountains the mean vapour tension decreases very rapidly with the height, on account of the rapid decrease of temperature as we ascend. If Dalton's law, that in a mixture of gases or vapours the pressure of each is the same as if it filled the whole space alone, were applicable to the atmosphere, as is sometimes supposed even yet, then the pressure or tension of vapour observed on the plains ought to be reduced one-half on ascending through 29,000 feet; but it is found by observation that a vapour pressure equal to half that observed on the plains is attained at an elevation of 7,000 or 8,000 feet. This was pointed out by General Strachey in the *Proceedings of the Royal Society* for March, 1861, where he has shown that the observations of Mr. Welsh in balloon ascents, those of Dr. Hooker in Sikkim, and his own observations in Kumaon (most of which are included in Table XII.), make it perfectly certain that the proportion of water vapour which exists at any given elevation is determined, not by Dalton's law, but simply by the temperature. The vapour raised from the earth's surface is constantly diffusing upwards, and would go on doing so until it attained the state of equilibrium represented by Dalton's law; but the temperature falls so rapidly as the height increases that saturation point is reached and the vapour is partially condensed into cloud or rain long before the barometric equilibrium is attained.

In the third column of Table XIII. the figures given in the previous table have been compared in a manner suggested by Strachey. The tension of vapour at sea-level under Kumaon and Garhwál has been computed for each month, by multiplying the mean of the observed tensions at Roorkee and Bareilly into the ratio between the tension of saturated vapour at the sea-level temperature and that of saturated vapour at the temperature of the plain; that is to say, the temperature is supposed to be corrected for elevation above the sea while the degree of saturation remains constant. The figures in Table XII. have then been divided by the corresponding tensions at sea-level, and the average of the fractions for all the months has been calculated for each elevation. Finally, from these results the ratio of the tensions at each even thousand feet above the sea has been found by interpolation. The second column of the table gives the results of Sir Joseph Hooker's observations in Sikkim compared with those taken at the meteorological observatory of Gwálpara near the foot of the hills, and the fourth column has been computed from the observations in General Cunningham's *Ladák* and those taken by Dr. Scully on the way back from Yárkand in 1875. The latter have been published in the *Indian Meteorological Memoirs*, No. VIII. The base station for the Kashmir group is Ráwal Pindi. The figures opposite 7,000 feet in the second and fourth columns are derived from the monthly means of the Darjiling and Marri observatories.

XIII.—Proportions of vapour tension at various elevations in the Himálaya.

Height.	Sikkim.	Kumaon.	Kashmir and Ladak.	MEAN FOR HIMÁLAYA.		
				Observed.	Computed by Strachey's method.	Computed by Hann's method.
Sea-level ...	1·00	1·00	1·00	1·00	1·00	1·00
1,000 feet ..	·89	·92	·92	·91	·91	·91
2,000 " ...	·83	·89	·85	·86	·83	·82
3,000 " ...	·74	·87	·69	·77	·75	·74
4,000 " ...	·67	·74	·52	·61	·68	·67
5,000 " ...	·64	·70	·51	·62	·62	·61
6,000 " ...	·59	·60	·57	·59	·56	·55
7,000 " ...	·53	·56	·60	·56	·51	·50
8,000 " ...	·50	·53	·41	·48	·46	·45
9,000 " ...	·44	·49	·28	·40	·42	·41
10,000 " ...	·40	·47	·27	·38	·38	·37
11,000 " ...	·37	·35	·26	·33	·34	·33
12,000 " ...	·35	·28	·21	·28	·31	·30
13,000 " ...	·30	·25	·23	·26	·28	·27
14,000 " ...	·27	·20	·19	·22	·25	·21
15,000 " ...	·27	·17	·15	·20	·22	·22
16,000 " ...	·22	·15	·16	·18	·20	·20
17,000 " ...	·20	·15	·14	·16	·18	·18
18,000 " ...	·19	·14	·15	·16	·16	·16
19,000 " ...	·18	·13	·14	·15	·14	·15

The mean of all three sets of observations probably represents very closely the actual diminution of vapour pressure on ascending in the Himálaya. It decreases with more regularity than either the Kumaon or Kashmir series of observations alone, and it agrees very closely with the series for Sikkim, where the relative humidity, or percentage of saturation, varies much less than in the western Himálaya. The last column of the table but one gives a series of ratios calculated on the assumption that the degree of humidity is the same at all elevations, and that the temperature of the southern slope of the Himálaya decreases at the mean rate above found—one degree in 361 feet. This series agrees very closely with the average of the results given by observation; though from 2,000 to 10,000 feet the calculated ratios are all considerably less than those observed in Kumaon. During the hot-weather months the degree of saturation on the plains below Kumaon falls exceedingly low, while on the hills, as has already been stated, the air remains much moister; at Dehra, for example, the vapour pressure in March, April, May, and June is greater than at Roorkee owing to local evaporation. Thus on the average of the year the relative humidity of the air in the Kumaon hills is considerably greater than over the plain. On the other hand, the observed ratios from 14,000 feet upwards are less than those given by calculation, because most of the observations at these altitudes were made at places lying behind the snowy range.

In the last column are given the ratios calculated by the logarithmic formula, $\log p = \log P - \frac{h}{23068}$, where h is expressed in feet. Dr. Julius Hann, in an article in the Austrian Meteorological Society's Journal for 1874, page 193, has deduced from all the available observations on mountains and in balloons a similar formula in which the numerical constant is 6,517 metres, or 21,382 feet. On the assumption that this formula holds good to some distance beyond the limits of observation, we find that an elevation of 23,000 feet, or about the average height of the snowy peaks, the quantity of vapour in the air is only one-tenth of the quantity at sea-level. The extreme dryness of Tibet and Ladák is thus easily accounted for.

The logarithmic formula has the advantage of enabling us to calculate approximately the total quantity of vapour in the air at any time, by an application of the integral calculus. Using the generally received values for the density of water vapour and its co-efficient of expansion with heat, and extending the integration to an infinite height above the ground, it is found that the depth of water that would be formed by the complete condensation of the vapour over a given area is almost exactly three times the height of the mercurial column which measures the pressure of the vapour at the bottom. In the rainy season for example, when the pressure of vapour over the Indian plain is equal to about an inch of mercury, the complete precipitation of the vapour would yield only three inches of rain, that is, less than the quantity which sometimes falls in two or three hours. A continuous downpour amounting to fifteen or twenty inches, such as frequently occurs in India, must be fed by a powerful indraught of moist air.

The relative humidity of the air is probably greater at all elevations on the Himálayan slope than either on the plains or on the Tibetan plateau beyond the Indian watershed; and it is doubtless greater on forest-clad slopes and valleys than on steep and bare mountain sides. On a high ridge, too, which intercepts and deflects upwards the prevailing south-west winds, thereby cooling them and partially condensing their vapour, the degree of saturation is greater than on the lower ridges or valleys behind it; for the air in sinking after crossing the high ridge is warmed and rendered capable of absorbing more moisture than it has been able to retain in crossing the ridge. Thus Naini Tál, independently of the influence of the lake, is always much moister than Ránikhet or the notoriously dry and bare station of Almora. The registers of the meteorological observatories do not, however, illustrate this very well; for at several of them observations have only been taken in the daytime, when the relative humidity is below the mean; and the humidities recorded at the old observatory of Naini Tál are quite untrustworthy and in many cases impossible. At Bareilly, Roorkee, Ránikhet, and Chakráta observations were taken both night and day for some years, at the hours of ten and four. If the means of the four observations at these hours be adopted as daily means, Chakráta appears to be the most humid of the four stations, and Roorkee and Ránikhet the driest, though the difference between Chakráta and Roorkee or Ránikhet is less than might be anticipated. The humidities of the other places in Table XIV. have been calculated approximately from the monthly means of temperature and vapour tension. The figures for Leh in the winter months are doubtful; the psychrometer generally giving unreliable results when the temperature falls much below freezing.

XIV.—Approximate mean humidities of places in the Himálaya.

Place.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Bareilly	...	69	63	51	39	43	59	82	83	81	70	65	69	65
Roorkee	...	69	65	53	36	37	54	78	80	77	65	62	68	62
Dehra	...	69	69	58	47	45	63	86	90	86	69	62	67	70
Dharmsála	...	83	73	67	57	51	55	79	80	77	69	56	67	68
Mussooree	...	66	64	53	45	49	62	99	99	98	70	61	72	70
Ránikhet	...	60	58	52	39	49	61	85	86	79	60	53	54	62
Chakráta	...	68	64	56	49	57	68	94	94	89	64	49	58	67
Leh	...	100	100	79	57	52	50	62	66	68	63	67	71	70

The relative humidity of the air at all elevations up to 11,500 feet is subject to a double annual variation, one maximum occurring at the time of greatest cold, and the other in the middle of the rainy season. At Leh the summer maximum is very faintly marked, nine-tenths of the vapour brought by the south-west monsoon being cut off before reaching the station, and at Dharmsála, north of the Panjáb, the air appears to be slightly more humid in winter than in summer. At all the other stations the maximum degree of humidity is reached in August.

In April and November the air is dry, especially in the former month, when, during hot winds from the north-west, the percentage of saturation over the plains often falls as low as 5 or 6. In the hills, at Almora and Ránikhet, the humidity of the air frequently sinks to 25 per cent., but is seldom less than 20 per cent. The month of November and the beginning of December appear to be quite as dry as April at the higher hill stations, where these months are rainless, while showers sometimes fall in April; but on the plains, because of the low temperature of November and the moisture left in the ground by the summer rains, the air is still comparatively moist. In the cold weather the Sub-Himálayan stations are more humid than the hill stations on the average of the twenty-four hours, probably because the air, which is cooled and has its relative humidity increased by radiation during the night, drains away from the hills and collects over the plain. At this season the air at the hill stations appears to be drier in the mornings than in the evenings.

The humidity of the upper regions of the atmosphere, as indicated by clouds, is always greater in the daytime than at night. On the outer slope of the Himálayan chain the variation is doubtless quite as distinctly seen as anywhere else in the world, but it has not been recorded in the observatory registers, where only the amounts of cloud seen at 10 A.M. and 4 P.M. have been entered. The variation is, however, probably very similar to that which occurs over the plains, where the sky is most serene about 10 P.M. and most cloudy at the hottest time of the day, when the upward convection currents are strongest. In Table XV. the figures represent the means of the 10 A. M. and 4 P. M. observations, and they are therefore a little above the true mean for the day.

XV.—Average proportion of cloudy sky in tenths of the expanse.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Bareilly ...	2·87	3·12	2·97	1·96	1·46	3·98	7·11	6·18	4·50	0·73	0·72	1·85	3·12
Roorkee ...	2·96	3·47	3·12	2·25	1·71	2·90	4·97	4·50	4·58	0·99	0·82	2·18	2·87
Dehra ...	3·73	4·07	3·55	2·50	2·75	4·02	7·50	7·00	4·83	1·08	1·33	2·74	3·76
Dharmsála ...	4·99	3·91	3·42	2·17	2·60	3·26	7·60	6·76	4·09	0·74	0·95	2·02	3·54
Ránikhet ...	3·66	4·42	3·78	3·34	3·58	5·41	8·58	8·42	5·64	1·69	1·31	2·99	4·40
Chakráta ...	4·23	4·75	4·44	3·42	3·75	5·14	8·89	8·57	6·79	2·28	1·74	3·62	4·80
Leh ...	6·32	6·38	6·27	5·78	5·77	5·50	4·89	4·68	4·44	4·19	5·12	5·91	5·44

The annual variation of cloud is similar to that of the relative humidity of the air near the ground. It has two maxima, in the cold weather and the rainy season, and two minima, in April or May and in November. April is cloudier than November, probably because the upward movement of the air during the day then prevails over the downward movement at night, while in November the prevalent movement is downward. In this way the air in the upper strata is dynamically cooled in the hot-weather months and dynamically heated in November. The variation of humidity at the hill stations is intermediate in character between that observed on the plain and the variation in the cloud-bearing strata of the atmosphere.

No direct observations of the heights of clouds above the ground have been made in the Himálaya. The ordinary clouds of the rainy season that look like broken cumulus from below are often not more than 5,000 or 6,000 feet above sea-level, hill stations like Naini Tál and Mussooree being frequently enveloped in them for days. They sometimes even extend down to the level of the plains, the whole mass of the mountains up to the snows being then shrouded in fog. From the vapour tensions given in Table XIII., and the temperature decrements in Table V., it is possible to calculate approximately the average height at which a mass of air rising up from the plain would reach the dew-point and begin to form cloud. In January this height is a little over 4,000 feet above the plain, or about 5,000 feet above sea-level. In April and May the height above the plain is 8,000 feet, and at this time of the year it is rare to find clouds resting on the outer ridges of the Himálaya, though great banks of them are formed every day along the southern face of the snowy range. In the rainy season, that is, between the middle of June and the end of September, the average height at which clouds would commence to be formed in a rising column of air is 3,100 feet above the plain or about 3,900 above sea-level. This probably coincides very nearly with the zone of greatest rainfall on the mountains. In August, when the air is most humid and rainfall most frequent, the average lower limit of cloud is probably about 3,200 feet above the sea.

Regarding the upper limit of cloud nothing is known. The light feathery ice-cloud called cirrus, seen above the plains of Tibet and the passes over the Indian watershed, appears quite as high as when viewed from the Indian plain. It is probably formed at all elevations to which water vapour extends, though what the upper limit of vapour is we do not know. If we assume the cirrus clouds over the Tibetan plateau to be twice as high as the plateau itself, say 30,000 feet above sea-level, the quantity of vapour in the air would be only one-twentieth of that observed on the plains of India, but it would probably be quite sufficient to form light clouds.

Rain and snow.

The distribution of rain both on the plains and on the mountains has already been described in a general way. The plains of Northern India, between the mountains and the Jumna river, or a line drawn north-westward from Delhi beyond the river, may be divided into roughly parallel zones of equal rainfall, that which receives the greatest amount of precipitation lying nearest to the Himálaya. The breadth of each of these zones gradually diminishes towards the north-west and widens out in the direction of Bengal, because, the prevailing wind of the rainy season being easterly over the plain, the supply of vapour gradually diminishes and the rains become lighter as we pass from east to west. In Table XVI., the average monthly rainfalls of 15 places on the plains near the base of the hills of Kumaon, Garhwál, and Dehra Dún, are given. The first group of stations is at an average distance of 20 to 30 miles from the base of the hills, and the distance of the other group is under 20 miles. In both groups the stations are arranged in order from east to west. The table might be extended indefinitely in both these directions as well as southwards, but little would be gained by doing so, since the distribution of rain above described is seen clearly enough from the figures as they stand.

The average rainfall of the line of stations at a distance exceeding twenty miles from the Himálaya is 40·1 inches, and that of the stations at a distance less than twenty miles is 46·6 inches. In each group the total rainfall gradually diminishes in passing from the extreme east of Rohilkhand to the neighbourhood of the Ganges, where it increases suddenly and again gradually shades off to the westward. The mean wind directions for the rainy season at Roorkee, Meerut, and Delhi indicate that there is frequently a sort of eddy formed at that season near the upper course of the Ganges, probably by the meeting of the south-east winds of the plain with south-west winds from the Arabian Sea that have been deflected northward by the Aravali hills in Rájputána, and this may be the cause of the increased rainfall that is observed.

On the mountains the rainfall varies rapidly with height, and its quantity is to a very great extent dependent on the situation of the place to the windward or leeward of high ridges and peaks. At fairly exposed stations of nearly equal altitudes there is a gradual diminution of the annual rainfall on passing from west to east, and between the Ganges and Jumna there is a slight increase perfectly comparable to that which occurs on the plain in the districts of Bijnor and Sahâranpur. Thus the annual rainfall of Darjiling is 120 inches, that of Naini Tal 91 inches, that of Mussooree 95 inches, and that of Chakráta, Simla, and Marri 62, 68, and 58 inches respectively.

The next table gives the average monthly and annual rainfall of twenty places on the Himálayan slope, classified into three groups according to their positions near the foot of the slope, on the outer high ranges or on the inner ranges and valleys.

XVI.—*Rainfall of stations on the plains near the base of the Himálaya.*

Station.	Elevation in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		"	"	"	"	"	"	"	"	"	"	"	"	"	
Nawábganj	640	1·28	1·15	0·55	0·27	1·29	5·82	16·94	11·79	8·02	1·51	...	0·49	49·11	16-17
Baheri	690	1·12	1·40	0·63	0·28	1·25	5·35	17·62	11·59	6·55	1·16	0·02	0·43	47·40	16-17
Thákurdwára	720	1·55	1·63	0·73	0·56	1·06	5·95	14·02	11·71	5·91	0·79	...	0·63	44·54	16-17
Bijnor	800	1·14	1·22	0·86	0·54	0·70	4·81	10·47	9·32	5·41	0·53	0·05	0·40	35·45	31·33
Deoband	870	1·31	1·60	1·20	0·31	0·88	2·86	10·31	8·16	3·49	0·28	0·03	0·61	31·04	16-17
Sahárunpur	950	1·42	1·51	1·09	0·42	0·82	4·46	12·32	9·77	3·68	0·50	0·16	0·61	36·76	31·33
Ambála	820	1·41	1·38	1·01	0·63	1·03	4·18	11·53	8·75	4·57	0·84	0·14	0·71	36·18	25-26
Puranpur	620	1·32	1·90	0·53	0·50	0.62	5·39	20·28	15·00	8·80	2·25	...	0·82	57·41	6-7
Pilibhit	650	0·99	1·41	0·45	0·37	1·15	6·25	16·17	12·06	9·72	1·31	...	0·48	50·36	16-17
Rudarpur	720	1·18	1·42	0·80	0·32	1·16	5·74	15·11	11·30	5·39	1·02	...	0·47	48·91	20-21
Káshipur	750	1·48	1·53	0·79	0·49	1·43	6·05	13·53	11·70	5·29	0·83	...	0·69	43·81	16-17
Dhámpur	780	0·96	1·84	0·74	0·58	0·95	4·22	13·12	11·87	5·29	0·50	...	0·63	40·70	16-17
Nagina	850	1·18	1·79	0·81	0·54	0·95	5·03	14·24	13·02	6·24	0·54	...	0·72	45·06	16-17
Najibabad	870	1·49	1·92	0·92	0·78	1·02	5·64	15·50	14·11	7·23	0·88	...	0·71	50·20	16-17
Roorkee	890	1·95	1·63	0·95	0·36	1·04	4·83	12·62	12·05	4·75	0·72	0·19	0·42	41·51	26-27

XVII.—*Rainfall on the Himálayan slope.*

	Station.	Elevation (in feet).	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
			″	″	″	″	″	″	″	″	″	″	″	″	″	
Bhábar, Siwáliks, and Dehra Dún.	Kilpuri	800	1·32	1·72	0·84	0·56	1.35	8·08	19·86	15·63	8·79	1·46	0·01	0·50	60·12	16-17
	Haldwáni	1,430	1·40	3·18	1·78	0·79	1.32	10·61	21·74	20·67	10·51	1·45	...	0·61	74·06	16-17
	Hardwár	1,100	2·98	2·80	1·04	0·08	0.45	4·38	10 33	16·59	5·56	1·03	0·06	0·39	45·69	5-6
	Mohan	1,330	3·65	2·91	1·82	0·83	0·79	9·23	19·86	17·48	5·70	1·72	0·58	0·50	65·07	4
	Bhogpur	2,450	1·47	3·27	1·23	1·27	4·87	8·63	57·83	58·30	19·92	0·80	...	0·10	1 57·69	2-3
	Dehra	2,230	2·06	2·10	1·41	0·73	1·39	8·32	24·61	23·66	9·14	0·75	0·07	0·32	74·86	31-33
	Ambári	1,800	1·67	2·38	0·85	1·13	2·67	11·65	24·58	23·73	8·20	0·42	...	0·55	77·83	2-3
	Kálsi	2,000?	2·21	3·42	2·22	0·96	1·54	8·02	25·09	26·91	10·04	0·89	0·04	0·99	82 33	16-17
Outer ranges.	Naini Tál	6,600	3·04	3·24	2·34	1·78	2·97	15·42	24·60	28·77	10·24	1·80	0·15	1·59	90·94	30-31
	Mussooree (St. Fidelis's, School).	3,850	2·48	3·67	1·47	3·27	4·28	13·99	37·16	54·30	19·20	0·20	...	2·23[1]	142·25	1-3
	Mussooree (Hospital) ...	6,550	2·00	3·29	2·98	1·90	2·71	9·90	29·35	31·27	9·64	1·09	0·09	1·01	95·23	16-28
	Chakráta	7,052	1·41	3·05	3 41	1·88	3·13	7·97	17·23	16·31	5·94	0·61	0·13	1·16	62·23	11-12
	Landaur	7,511	2·47	1·44	1·68	2·49	4·60	7·24	26·41	30·86	7·69	0·62	0·68	0·95	87·13	5
Inner ranges and valleys.	Champáwat ...	5,550	2·12	3·59	2·23	1·49	3·54	7·46	14·93	11·36	6·72	2·14	...	0·97	56·55	16-17
	Pithorágarh ...	5,500	1·72	2·83	1·84	1·72	3·28	7·68	13·14	9·92	4·59	1·38	...	0·82	48·92	16-17
	Almora	5,490	1·88	2·08	1·54	1·09	2·16	5·90	9·84	8·11	4·57	0·93	0·19	0·65	38·94	35-37
	Bánikhet	6.069	1·64	2·61	1·60	1·62	3·11	5·81	13·69	11·11	5·05	0·78	0·08	1·18	48·28	9-10
	Pauri	5,350	2·61	2·98	2·29	1·29	2·63	5·42	13·71	12·65	5·03	0·64	0·20	0·77	50·22	30-31
	Srinagar	1,750	2·20	3·44	2·38	1·05	2·25	4·35	8·80	8·05	2·71	0·66	0·02	0·72	36·63	16-17
	Leh	11,538	0·10	0·01	0·01	...	0·05	0·03	5·20	0·71	0·21	...	...	...	1·32	3

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[1] Interpolated from upper station in some years.

The influence of an elevated ridge in diminishing the rainfall of the valley behind it is seen on comparing the rainfall of Almora with that of Naini Tál, or even by comparing Srinagar with Pauri, though both of these lie far in the interior of the mountain system. A much greater contrast is observable between Bhogpur, at the foot of the mountains overhanging the gorge of the Ganges above Hardwár, and Dehra, in the Dún, behind the central and highest part of the Siwálik chain. The rainfall of Bhogpur, given by the observations of two and a half years is, however, probably too high.

The variation of rainfall with height can only be roughly determined, because every high ridge and peak thus cuts off the supply of vapour from the lower ground to the north of it. In Table XVIII. an attempt has been made to determine it approximately from the rainfall figures in the first two sections of Table XVII., together with those of two or three places in the hills north of the Panjáb and the observations made by General Strachey at Niti in 1849. The ratio between the mean rainfall of each hill station and that of the nearest station or stations on the plains, for the same years, is given in the last column.

XVIII.—Rainfall of the outer slope of the Himálaya compared to that of the neighbouring plain.

HILLS.			PLAINS.			Difference of elevation.	Rainfall ratio.
Station.	Height in feet.	Rainfall.	Nearest station or stations.	Height in feet.	Rainfall.		
		″			″		″
Kilpuri ...	800	60·1	Rudarpur ...	720	43·9	80	1·37
Hardwár ...	1,100	45·7	Roorkee ...	890	40·2	210	1·14
Patháukot ...	1,160	50·2	Gurdáspur ...	900	30·1	260	1·67
Mohan ...	1,330	65·1	Roorkee ...	890	39·8	440	1·64
Haldwáni ...	1,430	74·1	Rudarpur ...	720	43·9	710	1·69
Ambári ...	1,800	77·8	Sahárанpur and Ambála,	890	30·0	910	2·59
Kálsi ...	2,000	82·3	Ditto ...	890	34·0	1,110	2·42
Núrpur ...	2,050	79·3	Gurdáspur ...	900	30·1	1,150	2·60
Dehra ...	2,230	74·9	Roorkee ...	890	41·5	1,340	1·80
Bhogpur ...	2,450	157·7	Ditto ...	890	30·0	1,560	5·26
Pálampur ...	4,000	118·0	Gurdáspur ...	900	28·7	3,100	4·11
Dharmsála ...	4,490	123·2	Ditto ...	900	33·1	3,590	3·72
Mussooree (1)	5,850	142·2	Roorkee ...	890	32·0	4,960	4·44
Mussooree (2)	6,550	95·2	Ditto ...	890	41·5	5,660	2·29
Naini Tál ...	6,600	90·9	Rudarpur ...	720	43·9	5,880	2·07
Simla ...	6,950	68·6	Ambála ...	820	36·2	6,130	1·90
Chakráta ...	7,050	62·2	Sahárаnpur and Ambála,	890	36·4	6,360	1·71
Landaur ...	7,510	87·1	Roorkee ...	890	42·5	6,620	2·05
Niti ...	11,460	5·5[1]	Roorkee and Rudarpur,	800	45·0[1]	10,660	0·12

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[1] Rainfall of July, August and September, 1849; the observations at Niti taken by General Strachey.

By grouping together the ratios for the places lying between the even thousands of feet, many of the irregularities that appear in Table XVIII. are cleared away and the results may be accepted with more confidence. The excessive rainfall of Bhogpur, for example, will to some extent counterbalance the defect at Dehra caused by the position of the latter station behind the ridge of the Siwáliks. The following figures are thus obtained :—

Height above plain.			Mean height.	Rainfall ratio.	
				Observed.	Calculated.
		Feet.	Feet.		
0 to	...	1,000	435	1·68	1·83
1,000 „	...	2,000	1,290	3·04	3·01
3,000 „	...	4,000	3,350	3·91	3·77
4,000 „	...	5,000	4,740 [1]	3·48	3·15
5,000 „	...	6,000	5,770	2·18	2·39
6,000 „	...	7,000	6,370	1·89	1·89
10,000 „	...	11,000	10,660	0·12	0

The ratios in the last column are calculated by means of a formula, $R = 1 + 2{\cdot}12\ h - 0{\cdot}47\ h^2 + 0{\cdot}025\ h^3$, given in the official *Report on the Rainfall of the North-Western Provinces and Oudh*, published in 1879. It was originally computed from somewhat different data, but it represents the observed ratios in the above table as closely as can possibly be expected, considering the nature of the observations. At elevations greater than 9,585 feet above the plain this formula gives increasing values for the rainfall, and is therefore inapplicable; but from 7,000 feet above the plain upwards the rainfall ratio may be approximately represented by a logarithmic formula, $\log R = 2{\cdot}151 - 0{\cdot}287\ h$. In both formulæ h is to be expressed in thousands of feet.

The mean rainfall along Rohilkhand and the Doáb, at a distance of twenty miles from the hills, is about 43 inches, and the mean elevation of this line above sea-level is 800 feet. Applying the formulæ in the preceding paragraph to these data, we find that the average rainfall on the southern slope of exposed mountain ridges in Kumaon and Garhwál would probably be the following :—

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[1] The observations for the lower Mussooree station being for a very short period only, the figures for the stations immediately above and below it in Table XVIII. have been included in striking the average.

At	800	feet	above the sea	43 inches.
„	1,000	„	„	60
„	2,000	„	„	125
„	3,000	„	„	159
„	4,000	„	„	164
„	5,000	„	„	149
„	6,000	„	„	122
„	7,000	„	„	88
„	8,000	„	„	52
„	9,000	„	„	27
„	10,000	„	„	14
„	11,000	„	„	7
„	12.000	„	„	4

From the table it appears that the maximum rainfall occurs about 4,000 feet above the sea. The exact height of the maximum zone determined by the formula is 2,948 feet above the plain, or about 3,750 above sea-level. This agrees very closely with the mean altitude at which a rising column of air reaches its dew-point in the rainy season.

By far the most important if not the only cause of rain in the Himálaya is the cooling of the air by expansion as it ascends the mountain slope. It has been already seen that in the rainy season, the direction of the wind at all elevations in the Himálaya up to 15,000 or 16,000 feet, if not higher still, is from some southerly quarter. Near the foot of the hills the prevailing direction is south-easterly, but at most of the stations from the level of Dehra Dún upwards the wind blows from some point to the west of south ; that is, more or less nearly at right angles to the axis of the mountain zone. The air in rising to surmount the barrier has its heat rapidly converted into the work of expansion, and it commences to precipitate rain when the temperature falls to the dew-point. When once condensation begins, the rate of decrease of vapour with height will be a measure of the quantity condensed or the rainfall. This rate is greatest at the lowest elevations ; and thus rain should be heaviest at places on the outer slope of the mountains where a rising stream of airs usually begins to precipitate moisture, as the observations prove to be the fact.

The slight rainfall of places like Almora and Srinagar, to the leeward of a higher mountain mass is caused by the partial exhaustion of the vapour in crossing the mountains and by the dynamical heating of the air as it streams down towards the valley, both causes diminishing the tendency to condensation. The rapid decrease of rainfall on ascending beyond 6,000 or 7,000 feet is due simply to the exhaustion of the vapour, but at all elevations the influence of high ranges in cutting off the supply of vapour is easily seen. Regarding the rainfall of 1849 on the Tibetan table-land, General Strachey says:—"In the country beyond Níti no register was kept; but during a week of rainy weather in the middle of August 1·5 inches fell at Níti, while at Sanjar, beyond the watershed, where I was then encamped, at 16,500 feet, the rain never exceeded a very faint drizzle, and could hardly have been susceptible of measurement." At the Leh observatory all through the summer the rainfall hardly ever exceeds a few drops, and the greatest fall in a month during several years was an inch and a half. Sir Joseph Hooker's experience in Sikkim supplies us with facts quite parallel to these. In August, 1849, he says 26·8 inches fell at Darjíling, while in the interior, at the same elevation, but in the rear of the first masses of snowy mountains only 12·5 inches were measured. Between the 8th of September and the end of the month only 1·7 inches fell at Mome Samdong, about 15,500 feet above the sea, while at Darjíling 10 inches fell, and other instances of a similar nature might be cited.

The variation of rainfall with season is very distinctly marked in India. At all the stations in Tables XVI. and XVII., and at almost every station on the North Indian plain, the driest month of the year is November. In the great majority of years no precipitation whatever occurs in this month or in the first half of December, except perhaps on the higher mountains towards the north-west where the winter snows usually begin before the end of November. About Christmas a few showers of snow usually fall on the outer hills, and at the same time there is a slight precipitation of rain over the plains of the Panjáb and the North-Western Provinces. These winter snows and rains increase in quantity and in frequency on the hills and in the north-west Panjáb until February or March, but on the plains of the North-Western Provinces and Behar the maximum occurs in January.

The cause of the winter rains and snows has already been pointed out in describing the annual changes of the winds. In October and about the beginning of November the air over Northern India is as near as it ever attains to a condition of statical equilibrium. It is subject to the diurnal oscillations called the barometric tides and to the accompanying mountain winds, but there is little permanent movement of the air in any direction. During the cold weather, however, the neutral plane of pressure gradually sinks and the south-west upper currents of the atmosphere are then forced to ascend the slope of the mountains where they precipitate more or less of the vapour they contain. On the lower hills the temperature increases so rapidly in March and April that the tendency to precipitation, and consequently the rainfall, becomes less than in January and February, though the upper currents continue to blow from nearly the same direction as in winter. Along the southern declivity of the great snowy range, however, thunderstorms are of daily occurrence at this time of the year, and above the snow line considerable quantities of snow are frequently precipitated. In Ladák the heaviest falls of snow observed by Captain H. Strachey in 1848-49 occurred in April; but during the three years, 1876-78, there was no precipitation at Leh in that month.

April and May are the months in which hail is most frequently noticed in the Himálaya. No regular registers of this phenomenon have been kept, but nearly every year several hailstorms occur in the outer hills, and the stones are often of large size. On the 11th of May, 1855, a hailstorm occurred at Naini Tal in which many stones of 6, 8, 10 and even 24 ounces were observed to fall, the circumference of these varying from 9 to 13 inches. In 1878 there was a storm in which large hailstones fell, some of them so heavy that they punched holes through the zinc roofs of the houses, while the quantity was so great that it lay in shady places, where covered with leaves, for nearly a month.

About the middle of June usually, and sometimes before the end of May near the foot of the hills, the hot north-west winds of the plains give way to sea winds from the Bay of Bengal. The whole of the lower atmosphere over India is then moving towards the Himálaya; and the upward deflection of the air currents by the mountains causes frequent precipitations of rain in the manner already described. The rainy season almost always commences sooner on the mountains than on the plains, for saturation is reached first at high elevations and then propagated downwards by the cooling effect of the falling rain drops and the cutting off of the sun's heat by clouds. At most places in India, and in the inner parts of the Himálaya, July is the rainiest month, but on the outer slope of the mountains August is equally or sometimes even more rainy, especially towards the north-west of the chain.

While the rainy season lasts, the parts of Ladák about Leh, and the Tibetan plateau generally, receive perhaps, on the whole, less precipitation than in winter, because the temperature is then so much higher than on the Indian side of the chain, this high temperature greatly decreasing the relative humidity of any air that may reach the plateau from the south. It is probable also that the high snowy peaks, lying above the limit of the monsoon current proper, receive less precipitation in summer than in winter. At the turn of the seasons, however, about the end of September, falls of snow amounting to several feet in thickness sometimes occur on the passes over the Indian watershed.

Shortly after the autumnal equinox, about the end of September or beginning of October, the rains cease all over Northern India. The sudden cessation of the rainy season seems to be in some measure determined by the rapid diminution of solar heat, as the sun retreats to the south of the equator. It is possibly to this that we must attribute the somewhat remarkable regularity of the recurrence of two or three days' incessant rain frequently experienced in Kumaon about the 20th of September. On the plains, also, it is well known to the natives of the country that if rain falls in the *nakshatra* (lunar mansion) of *Hathiya*—that is, in the last week of September or first week of October, it is likely to be heavy. Excessively heavy rain, like that of the 17th and 18th September, 1880, when 30 inches fell in little more than two days at Naini Tál and produced a disastrous landslip, cannot, however be thus produced by a simple loss of heat, but requires a powerful indraught of moist air to keep up the supply of vapour. The heavy rain observed on the plains at "the break-up of the monsoon," and probably also that which falls at the same time on the outer hills of Kumaon, must be due chiefly to the minor storms of a cyclonic character that are frequently formed near the head of the Bay of Bengal at the turn of the season, and pass inland in a north-westerly direction.

CHAPTER VI.

ECONOMIC MINERALOGY.

CONTENTS.

Mining history. Experiments in Garhwál. The Kumaon Iron Works Company. Causes of present poor returns. Mode of mining: excavation: removing the ore: crushing the ore: cleaning the ore: drainage. Smelting operations: refining the ore. Division of profits. Improvement needed in appliances: Chili furnace: English system. Outturn. Financial results of the settlement of the revenue derived from minerals. Gold: Tibetan gold-fields: Thok Jalung mines. Silver. Copper mines: Rái mine and its ores: Sira mines: Gaul and Sor Gurang. Bournonite. Copper mines of Garhwál: Dhanpur: Dhobri: Pokhri: Chaumattiya mines: Rája's mine: Nota mine: Thála mine: Danda mine: Tálapungla mine: Kharna mine: Agar Sera mine. Iron mines: Kumaon iron mines: Giwár mines: Garhwál mines: Nágpur: Dasauli: Iriyakot. Lead. Arsenic. Lignite. Graphite. Sulphur. Borax. Gypsum. Soap-stone. Asbestos. Silajít. Limestone. Building stone. Roofing slate. Alum.

Mining history.

THE mineral resources of the Kumaon division early obtained the attention which their traditional value assumed to be due to them, and it was one of the directions to the first Commissioner to procure specimens of the ores to be found in Kumaon and transmit them to the mint for assay. Specimens of copper ore from the mines in Sira and Gangoli were accordingly forwarded to Calcutta in 1815, but the report was not favourable; for, if the specimens sent were fair samples of the ores in general, it was doubted whether the mines could be worked to advantage.[1] The Government were, however, not satisfied with this report, and in 1817 deputed Mr. A. Laidlaw as mineralogical surveyor to accompany Lieutenant Webb's party through Kumaon. His orders[2] were to consider the examination of the mineral resources of the country his primary duty, though at the same time he should not feel himself debarred from bestowing attention on any other matters deserving of scientific research, so far as such investigation did not interfere with his more immediate duties. These instructions further go on to say:—"You should ascertain the existence or otherwise of mineral productions applicable to purposes of public use, or available as a source of revenue; and report on the practicability of bringing them to account. The existence of iron and copper ores in considerable quantity has already been ascertained; but as the working of these metals might injuriously affect important articles of British import, it is not designed that your attention should be occupied in detailing any practical arrangements for that purpose; you will not, however, consider yourself debarred from prosecuting enquiries into any circumstances regarding them which may be of sufficient interest to science to merit particular notice. In every part, indeed, of your researches it is the wish of Government that, in the first instance at least, you should contemplate rather the general capabilities of the country which you are to visit than the special means necessary for bringing them into action in any particular district; though, of course, the facility or difficulty with which metallic ores or other useful minerals could be raised and brought to market must be a leading point in your observations on them. The minuter details of machinery, mode of working, &c., are what it is meant to postpone, as these will be the subject of future determination, when the whole result of your survey shall be before Government."

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[1] To Government, dated 26th June, 1815: from Government, dated 18th January, 1816. For further information on the mineral resources of Kumaon see Moorcroft's Travels, I., 7; As. Res., XVIII., 236; Rec Geol. Sur., 1871, 19: II., 86: (Lawder) III, 43; J. A. S, Ben., VI., 653; Glean. in Sc., I., 230.

Graphite. Glean. in Sc., III., 280; J. A. S., Ben.. XXIV., 208; N.-W. P. Rec., III., N. S., 371; G. India Rec., XVII., 58.

Iron ores and works, N.-W P. Rec., XVIII., 1; Rec. G. India, Sup., VIII., 37: XVII., 1: XXVI.: Bhábar iron works, Agra, 1856.

Copper ores and works, J. A. S., Ben., VII., 934 (Drummond): VIII., 471 (Glasfurd): XII., 453, 769 (Lushington): XIV., 471 (Reckendorf); As. Res., XVIII., 289; N.-W. P. Rec., III., N. S., 22; Glean. in Sc., I., 228.

Lignite, As. Res., XVI., 387. 397.

[2] From Government, dated 11th July, 1817. Mr. Laidlaw died at Pithoragarh in 1836, and I have not been able to procure any of his original reports

In 1826 Captain J. D. Herbert submitted his report on the mineralogical survey of the province.[1] This was followed by a report[2] in 1838 by Captain H. Drummond, of the 3rd Light Cavalry, on the copper mines at Râi in Gangoli and at Sîra in Bárabísi. Captain Drummond had brought with him from England an experienced Cornish miner, Mr. Wilkin, to examine the mines already worked, and proposed that, with a view of ascertaining their actual value, a certain sum should be advanced by "Government for an experimental opening of such mines as might appear best suited to the object in view." This proposal was accepted[3] by Government, and a sum of Rs. 2,415 (subsequently increased by Rs. 1,000) was allotted to carry out the designs furnished by Captain Drummond. A report[1] on the experiments then undertaken was rendered by Mr. G. T. Lushington, Commissioner of Kumaon, in 1842.

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[1] To Commissioner, dated 10th January, 1826. [2] J. A. S., Ben., VII., 934; and Stat. Kum., p. 868. [3] To Commissioner, dated 26th November, 1838.

Experiments in Garhwál.

The place selected for the important purpose of determining the advantages or otherwise of working the mines under European superintendence was the Pokhri copper mine in pargana Nágpur in Garhwál. The works were carried on from 1838 to 1841 with a net loss to Government of Rs. 7,384. The Commissioner considered this complete failure to be due to the poorness and scarcity of the ores found, and not in the least to any want of skill or industry on the part of Mr. Wilkin, or any injudicious selection of the places for experiment. Mr. Reckendorf, a mining engineer, visited these mines again in 1845, and in commenting on the deductions to be drawn from Mr. Wilkin's experiment, gave it as his opinion that the operations then undertaken should not be considered as conclusive against the value of the mines.[2] The experiment should have been confined to driving a shaft some thirty or forty fathoms below the old mines, and not to collecting ores which might have been a good addition in smelting other ores, but the smelting of which alone could never be profitable.

Again, there were no proper appliances for smelting, the loss from which by the native method adopted was very great, and the ores used, from their nearness to the surface, had already lost much of their value by the slow metamorphosis of pyrites into sulphate of copper. On the whole, Mr. Reckendorf's opinion was favourable to more extended and expensive operations in the hands of a private company. Nothing of importance, however, resulted from this the first attempt to obtain some accurate information regarding the mineral resources of the Himálaya. Captain Drummond also combated[3] the conclusions arrived at by Mr. Lushington as to the mines not affording a fair field for investment of capital, and in support of his views quoted the testimony of Captain Glasfurd (Executive Engineer), Captain J. D. Herbert (Superintendent of the Mineralogical Survey), and the experts Wilkin and Reckendorf, who had actually visited and partially worked the mines. He urged that the sums hitherto expended were barely sufficient to pay for the expenses of discovering and laying open the lode, and were utterly insufficient to carry on the experiment in the only way in which it could be made to pay. Nothing was undertaken until 1852, when the mines were again opened on the same footing, but the result was failure as complete as before. No attempt has since been made towards placing the copper mines of Garhwál under European superintendence. In 1872, however, a European leased the mines and continued the extraction of the ore according to the native method, but was obliged to abandon the process, as he found the cost of the metal when manufactured more nearly approached the current rate for silver than that obtainable in the market for the best foreign copper. The copper mines in Kumaon have never been worked under European superintendence, and any remarks that I have to make on their value or fiscal history will be found under the notice of the mines themselves.

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[1] J. A. S., Ben., XII., 454, and Stat. Kum., p. 367.

[2] J. A. S., Ben., XIV., 471; and Stat. Kum., p. 385.

[3] In a pamphlet published in London in 1848, and Stat. Kum., p. 393.

Kumaon Iron Works Company.

Connected with the history of mining enterprise in Kumaon special prominence must be given to the Kumaon Iron Works Company still in existence, and whose origin is no doubt due to the continued belief, in spite of successive failures, in the possibility of turning the utilisation of the mineral resources of the province into a profitable investment. These had again in the regular cycle of inquiries become the subject of much speculation. From a review of the information before Government and the results of certain experiments made in 1856 the Directors of the East India Company sent out a Mr. Sowerby and a large staff of mining assistants in 1857 to carry on the smelting of iron on account of Government in the interior.[1] The fact was soon established that iron of an excellent quality could be manufactured at rates below the cost of iron imported from England, and a number of private individuals under the style of Davies and Co. were permitted to undertake operations for the same purpose in other parts of the lower hills.

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[1] Report on the Government iron works in Kumaon, with plans, specifications, and estimates for establishing iron works in Kumaon, and remarks on the iron deposits of the Himálayas by W. Sowerby, C.E., printed as No. XXVI. of the Sel. Rec., Government of India (Public Works Department), Calcutta, 1859. These papers give a review of the English, Ulverstone, Continental, Belgian and French, Rhineland, Black Forest, Bohemian and Styrian Iron Works, and estimates and plans for adapting the approved processes of those iron countries to the Kumaon mines.

The avowed object of the Government enterprise was to induce private companies to work by demonstrating the financial and physical possibility of carrying on iron works as a remunerative industry in this province. Messrs. Davies proposed to take over the tract between the Dhabka and the Bhakra, and their proposals were accepted, with an assurance that they might proceed in confidence to make their arrangements, as Government would grant the lease sought. They therefore took over the Khúrpa Tál works in the rains of 1858, and paid their cost price in 1863. This company also erected buildings at Káládhúngi at a cost of Rs. 1,25,000. On the failure of the Government works at Dehchauri Colonel Drummond offered to take them over at a valuation. These works were given over to Drummond and Co., who paid the capital under agreement into the treasury in 1861. The forest rules were relaxed in favour of both companies, so as to allow them entire control over the fuel supplies, and eventually in November, 1862, both companies were amalgamated under the title of the North of India Kumaon Iron Works Company (Limited). Soon after the formation of the company instructions were received from the Secretary of State to construct a tramway to Khurja on the East Indian Railway, chiefly, it would appear, to afford an outlet for the iron manufactures of Kumaon. The tramway was to be laid with cast-iron rails manufactured at Dehchauri, and the company lost no time in making several thousand maunds of pig iron. Before the rails were made, however, the Government announced its determination not to undertake this line itself, but to hand its construction over to the Oudh and Rohilkhand Railway. It was essential to the success of the enterprize that some such outlet should exist, and the company accordingly determined to close its works for a time and await the opening of the line.

A license was granted by Government, but, unfortunately for the company, not executed till it was too late, and the deed of agreement contained briefly the following clauses :—1.—That a capital of 3½ lakhs of rupees should be paid before execution of the deed. 2.—That the company should pay Rs. 83,585 as the liquidated value of the works at Dehchauri, Ramgarh, and Khúrpa Tál, made over to them by Government, in four instalments, on or before the 1st September, 1862, 1863, 1864, and 1865, respectively ; and in default of one payment the whole to become immediately due. 3.—To pay yearly, for the first three years from 6th June, 1861, a rent of Rs. 1,500, and thereafter a yearly rent of Rs. 2,500 and a royalty of one rupee per ton of cast or wrought iron produced, and eight annas per ton of iron ore raised and sold without being smelted; the said royalties not to be paid unless they exceed, and only so far as they exceed, the rents of Rs. 1,500 and Rs. 2,500 before named; payments to be made on the 1st May yearly. 4.—To erect during the third, fourth, and fifth years suitable furnaces with requisite appliances for the smelting or blasting of iron (no number mentioned), and during these third, fourth, and fifth years to manufacture at least 750 tons of iron per annum on an average, and thereafter till the end of the term of 50 years manufacture 2,500 tons of iron per annum on an average of three years, to be struck in May each year. 5.—That the area of the forest at the close of every ten years should be covered with at least nine-tenths of such timber like trees as stood upon it at the commencement of the term, and when less than nine-tenths the company should plant to the necessary extent, failing which they should pay for each default Rs. 20,000. 6.—Not to transfer their lease without the consent of Government. 7.—To keep all roads (not being public ways made by Government) used by them in repair, also their works. 8.—At the close of their term remove their buildings, &c., first giving Government the option of purchasing them at a fair valuation. 9.—On the failure to pay or manufacture as stipulated, Government to enter upon and possess the works. 10.—But if such failure is not due to the neglect of the company, they shall be free from such penalty.

The purchase-money of the Khúrpa Tál works was alone paid up, but the forfeiture clause was suspended by the local Government in 1868. The forest tract was never given over to the company in the meaning of the agreement, but its revenue has been separately collected and credited by Government. The license was not sent up from Calcutta till June, 1864, by which time the company had begun to see that the speculation would not turn out a profitable one. In fact the license deed was not prepared for signature until after the company had suspended operations, and then it was ruled by the Solicitor to Government that it ought not to be signed. The map of the tract to be given over to the company was not completed till 1869. So much for the relations of the company to Government, and the delay in dealing with its affairs which has been shown throughout. In June, 1861, permission was obtained for the company's manager to draw against their capital. This was expended with little result, and in 1864, as above mentioned, the company was wound up. This result was in a great measure, no doubt, due to the company being unable to raise capital in the market, owing to the defect, or rather the want, of title, which appears to be ascribable to no fault of their own. Since 1865 correspondence has been carried on in reference to the affairs of the company and plans have been proposed for its resuscitation. In 1872 the works were visited by Mr. Jones of the Roorkee Workshops and valued; he made them then worth Rs. 1,26,733, with a debt to Government of about Rs. 80,000. There can be no doubt that the works can hardly be said to have had a fair trial, and the valuable opinion of the Commissioner of Kumaon may be quoted to the effect that there is every reason to believe that, if carefully supervised and fed with capital, the works should at least turn out as favourable under any circumstances as the East Indian Railway. There is no doubt that, in the distance, the fuel difficulty exists, but at Dehchauri and Káládhúngi for many years this can scarcely be felt, and under penalties to replant, the company may fairly be allowed to have an unlimited supply from the neighbouring forest. At Ramgarh it is doubtful whether iron manufacture will pay, as the ore, though of the finest quality, lies at a considerable distance from any forests of any considerable magnitude, so that until it has been definitively settled whether coal does or does not exist in Kumaon the eventual absolute success of these Kumaon mines must remain problematical.[1] The increase of railways in Northern India and the development of the resources of this province must sooner or later press these difficulties into notice, and they will then obtain a final solution. "Too much has been written and too little done" hitherto in this direction.

Causes of present poor returns.

In reviewing the causes of the poor returns from the different mines, one that presses itself into notice on the most cursory inquiry is the comparative inaccessibility of the principal mines. The copper mines of Sira and Gangoli, equally with Pokhri and Dhanpur, are situated on high cliffs in the interior. The talcose and calcareous formations in which the ores are found occupy the high precipitous mountains which build up the outlying spurs of the principal range, and some lie within it. This chain itself is metalliferous, as the lead mines at Ghirti between Milam and Níti, the copper indications at Tola and elsewhere in the Juhár country, and the copper and iron mines at Polar near Rudrnáth combine to show. The absence of coal and the increasing cost of wood fuel, with the distance it has to be carried when the forests near the mines have been exhausted, materially enhances the cost of production, while the difficulties of carriage in the tracts where the mines lie are often such as almost to preclude the transport of ore for smelting, and the forests in the neighbourhood of most mines only suffice for the most moderate requirements. Another difficulty is the want of labourers. The present workmen only come to work in the mines from the latter end of October to the beginning of April, and many of the less productive mines have been abandoned owing to the miner class turning to agriculture and to supplying the labour market at Ránikhet and Naini Tál. This want, however, could be supplied from Nepál were regular wages and constant employment once established. Sea-borne copper, though inferior to native copper, is from its cheapness preferred, and until capital is invested in opening up the larger mines and conducting the whole operations on a sufficiently large scale to warrant the permanent investment of capital in machinery and proper furnaces, and other appliances for the more economical working of the ore, mining enterprise must remain as it is—a practical failure in this province. It may be said that these extended experiments have already been tried in the case of the Kumaon iron works, but this remark will scarcely apply, as that is another of those unsatisfactory operations which stopped just at the point where further progress would have decided the question for or against the possibility of making mining speculation a remunerative one in Kumaon. I shall now briefly describe the mode of working and the financial results of the settlements of the revenue from mines from the official reports and papers before describing each mine.

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[1] For the materials for this note I am indebted to the office of the Commissioner of Kumaon and a note drawn up by Sir Henry Ramsay, than whom the Company and Kumaon has no more warm well-wisher.

Mode of mining.

The mode of working the mines is the same in Garhwál and Kumaon, and the suggestions for its improvement will serve for all classes of minerals. A gallery or passage is cut in the face of the hill with such slight declivity outwards as is sufficient to carry off the water. These adits have more of the nature of burrows than that of the shafts known in European mining. The section is always small, and in those parts where the hardness of the rock occasions any difficulty in working the passage is scarcely sufficient to admit of a person in a creeping posture. In no place will it allow of an erect position. Where necessary, frames of timber formed of unsawn branches of trees, rudely and even carelessly constructed, are set up to support the roof and sides. Accidents are therefore not uncommon, and the frequently falling in of the mines is one result of these imperfect protections.[1]

Mode of excavation.

The ore as well as the rock is excavated by a very different kind of pickaxe, the handle being made of a piece of wood with a knob at one end, into which a piece of hard iron is thrust and sharpened at the point. This with a miserable iron hammer, wedge, and crowbar, constitutes all the apparatus that the native miner has to depend upon. It is plain that with such tools no hard rocks can be penetrated nor can the softer ones be worked with much facility, and to this fact may be attributed the universal smallness of the passages throughout the mines, as the native miner can have his passage no larger than the rock which encloses the ore and its matrix will admit of. Proper pickaxes and steel gads (wedges) should therefore be substituted instead of the inefficient tools in use, and when blasting may be required the necessary materials should be provided. The miners work during the day, using torches made of dry pine, and clear out on an average from ten to twelve maunds of ore.

Removing the ore.

The ore is removed from the mine by boys, who pick up the stuff with their hands and put it into skins, which they drag along the floor by means of a rope and cross handle attached to their neck to the entrance of the mine. In most mines the greater part of this work must be done in a creeping posture, the string from the skin being fastened around the waist of the dragger. In place of this method wheel-barrows or sledges on four wheels and shovels should be used when the passages are enlarged and properly supported with sawn timber.

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[1] Paras. 19, 20, Captain Herbert's report, already quoted.

Crushing the ore.

The ore or *dhún* being delivered at the mouth of the mine is reduced to a small size either by the water-mill or by the manual labour of women. A large stone is placed on the ground on which they lay the ores; they then, either with a stone or a large hammer, and more frequently the former, proceed to pulverize the ore and pick out the impurities. In this way a woman may manage one to two maunds (82lb avd.) a day, according to the hardness of the ores. In Cornwall a woman will pulverize from 10 to 15 cwt. per day, according, as in the former case, to the nature of the ores. The method in practice there is, first, to dispense with the picking; secondly, to have the ores elevated, so as to enable the individual to stand while working, and to have a plate of iron about a foot square and two inches thick on which the ores are broken with a broad flat hammer. The impurities are then finally separated by a peculiar mode of dressing the ores with a sieve, by which a boy gets through with from one and a half to two tons per day. The ores are conveyed to the women, and from them to the boys by a man who attends for that purpose.

Cleaning the ore.

The washing of the ore in Kumaon also is performed by women, who carry the stuff in baskets from the entrance of the mine to a stream, where they contrive by dabbling it with their hands to wash off the mud and finer particles of the earth. They then proceed to pick out all the pieces of ore they can get hold of; or, in the case of what may be submitted to the water in a commuted state, they work this against the stream, so as to gather it clean at the head of a small pit by handfuls; but, from the bad construction of the pits, it is with difficulty that this is performed. After picking up any larger pieces of ore which may have gone back with the stream, they scoop out the refuse with their hands, and then proceed with another charge. In Cornwall, one woman provided with a wheel-barrow and shovel for the conveying and washing of the ores, and a boy with a sieve for dressing them, as formerly mentioned, would accomplish a task equal to that of ten women on the system described.

Drainage.

The drainage of the mine is managed in a proper manner by an adit. But whenever any attempt is made to go below it, as is the case in most if not all of the mines, the water is then raised in wooden buckets, handed from one man to another until they reach the adit into which they are emptied. In this manner six, ten, or even more men may be employed, whilst only an inferior number can be spared for excavating the ores. At the Síra mine, for instance, six men were found constantly engaged in lifting up the water, and there were only two at the ores : the work done by these six men could be effected with a hand-pump by one man ; but in order to keep the pump constantly going, two men might be required, and the remaining four added to the number of those who are excavating.

Smelting the ore.

The furnace of the *Dhanauriya* or smelter is very simple, and is made of common stone and clay faced with slabs of quartzose schist, luted with a compost of chaff and clay. It is about 3¼′ long by 2¼′ broad, with an ash-pit about six inches square, all of which are built inside a house about 12′ by 14′, of which the roof is composed of planks. (Figs. A. B.) The operation of smelting takes about 28½ hours, during

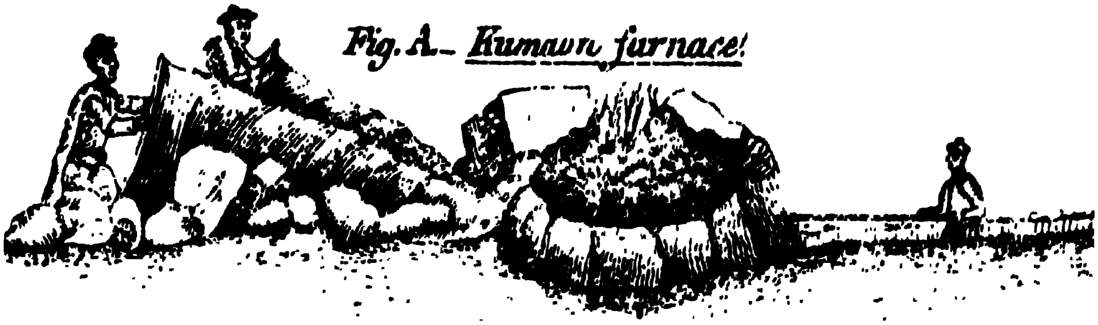
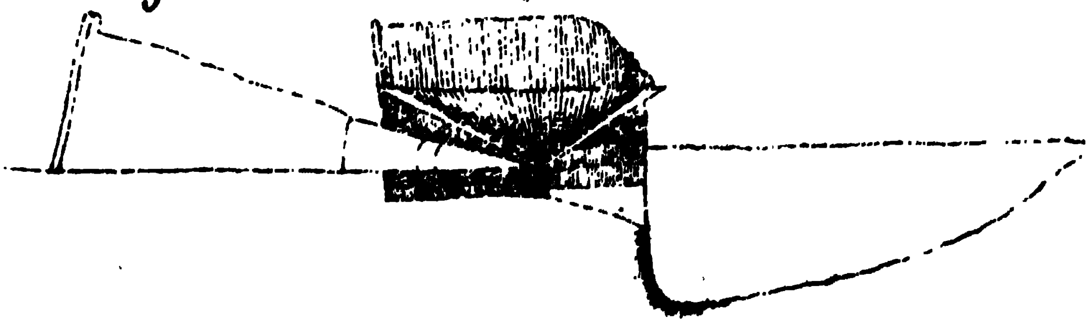


Fig. A.– Kumaon furnace.

Fig. B.– Vertical Section, from the front.



which time the fire is kept up, and after that the facing slabs and luting require renewal. The implements used are a crowbar, poker, shovel, and a pair of buffalo hides, dressed whole, to form the bellows, the neck of which forms the nozzle, and the buttock the valve for the ingress of air. The hides for making them are worth Rs. 12 apiece.[1] The furnace being freshly luted, the ash-pit is filled with charcoal dust and chaff, and a fire being lit, six baskets of iron ore, each containing about thirty sers (the ser = 2lb. 2oz. avd.), are placed round the fire. The blast is then commenced, one bellows being inflated while the other is undergoing depletion. In about half an hour the slag commences to flow from the floss-hole, which is kept open by a poker. In about two hours more, the ore having subsided considerably, two more baskets of ore and a corresponding supply of charcoal is given with a new luting for the bellows nozzle. In another two hours, this having also subsided, the charge is deemed ready. The fire is then raked out through the flosshole, and the charge, consisting of a pasty mass called *phalka* or *jhauj*, is shoved out with a crowbar by the smelter. The same operation is repeated until seven blooms are obtained, consuming thirty-eight baskets of ore, thirty-one of which are converted into the seven blooms, and the remainder, comprising the partially roasted ore, become the property of the smelter. The charcoal consumed weighs 340 sers, or a little more than the seven blooms, which weigh 327 sers, or about one-third of the ore expended (930 sers). Each bloom consists of three qualities of metal, all intermixed with earthy particles. These are kept separate, and are broken into small pieces before being sent to the *khatauniya* or refiner.

Refining the ore.

The furnace of the refiner is smaller than that of the smelter, and the implements required are a pincers, poker, two or three sledge-hammers, an anvil, and bellows. The fire being lit, a mixture of one-sixth of first quality, one-sixth of second quality, and the remaining two-thirds of third quality, in all about six sers of bloom metal, is placed on the hearth opposite the bellows, with the larger pieces nearest the fire. The blast having commenced, in a quarter of an hour the slag begins to flow, and in another quarter of an hour the metal (now a porous, pasty mass) is taken out of the fire and subjected to the blows of two or more sledge-hammers; the blows being slight at first, to prevent the metal flying into pieces, but as it becomes more solid, they are given with the full force of the workmen. Meanwhile a fresh supply of bloom-metal is placed on the hearth, as at first. The hammered mass, after several hammerings, assumes the shape of a small bar, weighing one and a quarter ser; it is thick in the middle and tapering to either extremity, and six sers of charcoal have been used in its formation. This bar is now fit for the market, and is called by the workmen *phala*, but by the plains-people *pain*. The charcoal used by the refiner is made from the dry trunks of fir trees which have been felled for two or more years, while that made use of by the smelter is made from small green wood. The refiner class is subdivided into another, called Bhadeliya, who, instead of making the iron into bars, manufacture it at once into cooking utensils. Nine hundred and thirty sers of ore produce 327 sers of bloom-metal, which in its turn produce 82 sers of marketable bar-iron, or only 8·8 per cent. The bloom operation consumes 340 sers of charcoal and the refining process 667 sers, so that for every ser of iron produced 8·2 sers of charcoal are consumed. The Swedish furnace only consumes 1·33 times the weight of the iron produced.

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[1] Beckett, III.; Sel. Rec., N.-W.P., 25.

Division of profits.

The mines are leased for a term of years to contractors for a certain sum, and the lessee collects for the season from the different classes of workmen at the following rates: from each *son* or miner Rs. 2½; from each gang of smelters Rs. 4½; from refiners of the Khatauniya class Rs. 4½, and from those of the Bhadeliya class Rs. 6. The miner is originally sole proprietor of the ore, which he takes to the smelter to reduce into blooms, giving him for his trouble one basket of ore (30 sers) and one basket of charcoal (5 sers) for each bloom turned out; also for each set of seven blooms 16 sers of grain, and food for one man for four days; and at the end of the season a suit of clothes. Sometimes, however, owing to the smelter being largely in debt to the miner, he does not receive any charcoal from him. The smelter can only work for certain miners, generally five in number, not being allowed to work for any other miners; or, in other words, each party of five miners employ one family of smelters exclusively.

Each party of smelters must consist of at least five persons, but they generally count eight to ten persons. The share of each party of refiners is one half of the bloom-metal made over to them to refine, no further remuneration being allowed them. Refiners, unlike the smelters, are not bound to work for any particular person, but may work for any one that chooses to patronize them.

Improvement needed in appliances.

In the roasting and smelting of the ore Captain Herbert recommends a system of reverberatory furnaces for these two different processes. An excellent material is at hand in the indurated talc known as potstone, which, though soft, is infusible. The simple blast furnace in use in Chili would also be an improvement. It is of a circular shape, similar to a lime-kiln, covered with a dome to confine and concentrate the heat. The ore is arranged in it in alternate layers with the fuël, which is wood, and being lighted it continues burning for a considerable time. When required, the heat is urged by a double pair of bellows worked by a crank turned by a water-mill.

Chili furnace.

English system.

The methods of reduction practised in England, where the subject is best understood, vary with the ore, and even with the establishment. But the differences are trifling and only affect the minor details. The two great objects to be effected are, first, by a proper calcining heat to drive off the volatile ingredients sulphur and arsenic, and to oxidate the iron, thereby promoting the fusibility of the ore and consequent separation of the metal from the scoria when in fusion; and, secondly, by an intense and properly continued fusing heat to effect the vitrification of all the impurities which thus form a slag at the top and are skimmed off while the metal sinks down in a comparatively pure state. To promote this vitrification of the ingredients occasional additions are made to the ore as the case may seem to require, though in general the run of the ores is such as to require little beyond a few slags of an old smelting. The operations of roasting and smelting are repeated several times, each smelting being followed by a roasting, to expedite which effect in the case of copper the ore is, after each smelting but the last, let into water to be granulated. This separation of the metal into such small parts assists the calcining power of the furnace, and the work is more speedily effected than if performed on the mass. After the last smelting comes the process of refining or poling, which consists in keeping the copper in a melted state covered with charcoal, and introducing from time to time a wooden pole into the melted mass to produce the evolution of gaseous matters. Lead is sometimes used both in Hungary and England to expedite the previous operations of the refinery. The oxides of this metal are amongst the most powerful vitrifiers known. As such they are effectual in the assay and refinery of the precious metals, and as such they may be also used with copper. But the process requires attention, for if not stopped in time, or if too much lead be added, the copper itself will be oxidated and vitrified.

The process of manufacturing iron from the ores is different from that of copper, inasmuch as none but the oxides or carbonated oxides of the former metal are ever employed. In the copper ores, that is in those which occur in any quantity, the metal is combined with sulphur, which can only be driven off by repeated roastings. In the iron ores the metal is united to oxygen and mixed with various earthy impurities. In reducing these ores, then, there are three distinct points to be attended to: first, the provision of a substance which shall effectually take the oxygen from the ore, leaving the metal mixed only with its earthy constituents; second, the proportioning the flux used to those earthy ingredients so as to insure a complete vitrification of them and separation from the metallic particles; and third, a sufficient heat to fuse the latter, that the separation and reduction may be more complete. The first point is attained by using a sufficient quantity of charcoal in the reduction of the ores; the second by adding, as the ore may require it, limestone or other flux; and the third point is only to be effected by using a powerful blast furnace.

Outturn.

It is not easy to give the outturn from the mines, the arrangements are so intricate and the returns so imperfect. In 1868 about 29 maunds of copper were raised from the Kumaon mines, and in 1869 the same mines yielded the same amount, of which 21 maunds were exported. The Dhanpur mines in Garhwál yielded 10 maunds of copper in 1869, but every year since the produce has decreased. In 1868 the Kumaon iron mines yielded about 2,000 maunds of metal, and the Garhwál mines about 1,752 maunds, while the returns of 1869 give

5,153 maunds for Kumaon and 529 maunds for Garhwál. Besides this an immense quantity of copper is imported into Kumaon in the shape of manufactured vessels for culinary purposes: about 2,000 maunds of iron also are imported from the plains against 155 maunds exported. No reliance can be placed upon the estimates of outturn in recent years, as the mines have been leased for a term of years, and the lessees are not inclined to have their affairs too closely examined.

Financial results of the settlement of the revenue derived from minerals.

Previous to the Gorkháli conquest of Garhwál the copper mines of Nágpur are said to have yielded Rs. 5,000 Gk. a year, or about Rs. 3,800 of our money. The entire mineral revenue of Kumaon and Garhwál, including mint dues[1] on the coinage of copper pice, had fallen in 1812 to Rs. 4,800 Gk., equivalent to Rs. 3,600 British currency.[1] This was mainly due to the neglect of the Gorkháli Government, under which the mines had fallen in and become choked with rubbish. Their suspicious policy prevented them from trusting their own officers, whilst their want of probity precluded any private person from venturing to sink the capital necessary to re-open the mines. In 1815 the Nágpur mines were leased for Rs. 10, and in the following year for Rs. 15, and with the villages attached to them seldom brought in more than Rs. 1,850 a year, whilst those in Kumaon were leased at Rs. 850 a year. Up to the year 1826 the revenue of the Kumaon mines was included in the assessment of pargana Rámgarh, and that of the Garhwál mines in pargana Dhanpur, and subsequently was accounted for in the returns of the pargana within which they are actually situated. Between the years 1815 and 1840 the revenue derived from mines averaged as follows:—

	Kumaon.	Garhwál.	Total.
	Rs.	Rs.	Rs.
Copper	801	2,086	2,887
Iron	1,905	226	2,131
	2,706	2,312	5,018

The highest mineral revenue of the province for any one year amounted to Rs. 5,417. This return was not altogether due to the smelting of ore, and included the land revenue of villages attached to the mines for the location and support of labourers. Mr. Beckett in his report[1] on the settlement of Garhwál gives the revenue of each mine from 1839-40 to 1863-64. The revenue every fifth year from each class of mine during this period was as follows:—

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[1] These mint dues were collected for a few years under British rule at the mines of Dhanpur and Gangoli, and at one-half per cent. yielded a revenue of Rs. 800 a year. To Board, dated 6th August, 1821.

Class of mine.	1839-40.	1844-45.	1849-50.	1854-55.	1859-60.	1863-64.	Total revenue from 1838-39 to 1863-64.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Iron ...	609	727	779	430	272	134	3,764
Copper ...	1,990	2,442	2,138	1,305	81	627	21,304
Lead ...	...	5	3	3	...	10	64
Total ...	2,599	3,174	2,920	1,738	353	771	25,132
Number of mines worked,	24	25	23	17	11	30	76

In 1865 there were 24 iron, 9 copper, and 2 lead mines worked in Garhwál, and 33 iron, 35 copper, and 3 lead mines had been abandoned. The lead mines have since been abandoned, and the revenue from copper and iron mines in 1878-79 was as follows:—

	Copper.			Iron.			Total.		
	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.
1878	86	8	0	136	12	0	223	4	0
1879	89	0	0	153	8	0	242	8	0

There are no statistics of outturn for these years.

In his Kumaon settlement report Mr. Beckett gives the revenue of each mine from the year 1844-45 to the year 1872-73. The revenue every fifth year from each class of mine during this period was as follows:—

Class of mine.	1848-49.	1853-54.	1858-59.	1863-64.	1868-69.	1872-73.	Total revenue from 1848-49 to 1872-73.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Copper ..	100	48	*Nil.*	120	67	30	2,831
Iron ..	2,274	1,751	1,532	870	929	1,420	46,126
Total	2,374	1,799	1,532	990	996	1,450	48,957

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[1] Allahabad, 1866.

The following quotation from the Commissioner's report in 1874 gives the opinion of those best acquainted with the subject on the future of the mining industry in Kumaon:—"Iron and copper abound, but at the present value of labour the mines are worth very little. The *sons* or miners have, as a rule, given up their old trade and taken to contracts. The great attraction to miners in former times was the cheapness of grain in the Khetsari valley, where iron was most extensively manufactured. This advantage no longer exists, for the market at Ránikhet has doubled the price of grain, and the miners would be no longer content to exchange their labour for the small profits on iron. Copper mines are in no greater favour. Formerly some villages where the miners reside were included in the mining leases of Kumaon and Garhwál. These villages have been settled with the miners, therefore they are no longer servants of the contractor. Tea gardens and other labour markets offer much better terms than a contractor, who, at the least possible expenditure, tries to make the greatest possible profit. These contractors know nothing about the science of mining, and they have no money to expend in penetrating beyond the worked-out galleries. In fact the mines have collapsed, and without considerable outlay no reasonable profit can be expected. Labour is expensive, and English copper can be bought at a cheaper rate in the Almora bazar than the local miners can produce it with profit. I expect nothing more from native petty contractors than a pittance which they can realize by the resident miners working when convenient to themselves, when they give half of the ore to the contractors and keep the other half. No doubt there is abundance of copper in Gangoli; but any mines, copper or iron, that are now worked barely produce sufficient for local consumption. Agricultural instruments are made for the people of the surrounding country, and a few copper vessels; but all the mines in the interior are in remote places, and too far removed from a good market to be of much value."

Gold.

The gold exported from Kumaon is either obtained from the streams within the province, or is brought down by the Bhotiya traders from Tibet. Although no mine of this metal has been discovered in the province, there are indications of its existence in Garhwál. The sands of the

Alaknanda, Pindar, and Sona furnish a small amount of gold-dust. The Ganges also is auriferous as far as Lachhman Jhúla, and the Rámganga for a short distance below its junction with the Sona. The washing is nowhere a profitable occupation, and scarcely gives an average of four annas a day for each workman. The gold obtained by washing the sands of rivers paid a small duty during the Gorkháli rule, and was leased with the forest duties for a short time after the British occupation, but the amount was too trifling to render its continuance expedient, and it was accordingly abolished by Mr. Traill. Undoubtedly a greater return might be had from this source by the use of mercury, as in Australia, for the purpose of separating the gold from the sand; for as this is afterwards recovered by a simple process of distillation, the expense would be very little more than it now is. Captain Herbert found gold in a matrix of granite near the Alaknanda.

Tibetan gold mines.

The gold imported from Tibet by traders is chiefly taken in exchange for grain or cloth to balance their accounts, as rupees are taken by them at the hill fairs for the same purpose. The principal gold mines in Tibet, *sár-chaka*, are ten days' journey beyond the borax fields further north and north-east in a district otherwise uninhabitable, named *Sár-bachyád*. These are farmed or managed by a *sár-pan* or gold commissioner on a triennial contract direct from Lhassa. The lessee in 1845 was also Garpan Urku-wa at Gartoh, and paid Rs. 17,000 per annum for the lease. He had 170 miners at work, for whose subsistence he used to send supplies from Pruang. It would also appear to be sometimes the custom to sublet 'claims' at a tax of a *sárjao* or *jao* of gold, about 7½ mashas, or ten rupees.[1] The gold mines are worked by pits and shafts under ground, where the gold is found in its pure native state, and undergoes no other process than washing and shifting, and after that requires little or no refining. In this state, tied up in little bags called *sár-shu* (H. *phatang*), weighing about 90 grains, it forms the heavy currency of the country. A superstitious belief holds ground that no large nugget should be removed, as it belongs to the genii of the place, but the Láma of Gnari is said to have one weighing nearly a ser.

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[1] H. Strachey, J. A. S. Ben., XVIII. (2), 5 ; J. D. Cunningham, *ibid*, XIII. ; Herbert to Commissioner of Kumaon, 19th January, 1826.

Gold is sold at the same fairs as the borax, and is imported to the value of about Rs. 10 to 12,000 annually.

Thok Jalang mines.

The gold in the bags commonly current has usually not more than 7·73 specific gravity. Even the picked yellow grains have only a specific gravity of 11·96, showing that they are alloyed with some other metal. The grosser impurities appear to consist of iron more or less oxidised. One of Montgomery's pandits visited the gold mines of Thok Jalang in Rohtoh in 1867,[1] and describes it as a great excavation from 10 to 200 paces in width and 25 feet in depth, access to the bottom being by means of steps and slopes, the earth dug out being thrown on either side. The digging is carried on with a long-handled kind of spade or an iron hoe, the iron for which comes from Ladák. A very small stream runs through the gold field, and the bottom is consequently a quagmire during the daytime. The diggers dam up the water, leaving a sloping channel for an escape. A cloth is then spread at the bottom of this channel, and the channel is supplied by one man with the auriferous earth, and another gives water, so that the gold sinks to the bottom and is caught in the cloth at the end. Some nuggets weigh up to two pounds. The diggers come from the Tsang province round Shigatze or Digarcha. There are numbers of abandoned gold fields in different directions about Thok Jalang, and probably a whole series of them from Rohtoh to Lhassa. The Sárpan levies a tax of about half a tola (*saishu*), or two-fifths of an ounce, from each digger. There is no wood, and water can only be had from melted ice. A cold wind blows at all seasons, and, in consequence, the tents of the diggers are pitched in excavations in the ground to protect them from this wind. The dried dung of yaks, ponies, and sheep afford fuel. The Tibetans cook and eat three times a day, their food consisting chiefly of boiled meat, barley cakes, buttermilk, and tea stewed with butter : they also smoke a great deal. They always sleep with their knees close up to the head and rest on the knees and elbows, huddling all the clothing on to their backs. The price of gold at Thok Jalang was about 5½ to 6 rupees per *saishu*, or 30 rupees per ounce.

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[1] Rec.,G. I., H. D., 36.

Silver.

Silver was brought down to these provinces from Tibet in former times. It was imported into that country from those surrounding it (probably China), and does not seem to be found in Tibet itself in any quantity. It was sent into Tibet in a crude state in lumps called *doja* or *thaka*, of a general value of Rs. 165 each. Importations from that source have ceased for some time, owing possibly to the great and growing influx of silver in the shape of rupees from British territory. Formerly all borax, salt, &c., was bartered for grain, cloth, &c., but now, while a large amount is still disposed of in that way (probably to procure actual necessaries), still, whether it proceed from the increase of trade and the portability of coin for hoarding purposes, or from the existence of a greater demand for silver in Tibet, by far the largest amount of borax is disposed of here for British money. The Bhotiyas, too, state that our coin is largely current in Gartoh and the other large towns, and is preferred by the inhabitants there to the coinage of other countries. They ask for the *Chehar*á*dár Rupaya*, or face-printed money.[1] The difference in the exchange now made up in Government rupees cannot be less than eighty thousand to one lakh of rupees per annum. This trade in rupees dates from about 1820, when they began to displace the Srinagari and Ladáki rupees.

Copper mines.

The mines of copper in Kumaon and Garhwál have never been of much practical value either as a source of supply for local consumption or as offering a valuable return to labour and capital. They are still, however, deserving of notice, and we shall now describe each in succession, commencing with the Gangoli mines in Kumaon.

Rái mine.

The Rái mine in pargana Gangoli is the most important in Kumaon. The ore is chiefly pyrites in a matrix of indurated and sometimes slaty talcose and steatitic schists inclosed in dolomite. In some places the one, and in some places the other, forms the roof and sides of the mine. The dolomite has a large crystalline grain and great tenacity, and forms a perfectly durable work when excavated. The schists when massive may be depended on, and can be easily worked, but, as a rule, they occur of such inferior consistence, having much the appearance of re-united débris, that they require support, and often occasion much inconvenience and even danger. The ore occurs in the schists in numerous strings, having every appearance of being leaders, as they are called, to solid ore, and forming a distinct lode. The strike or direction of the strata is nearly W.-N.-W. to E.-S.-E., dipping at an angle of about 45° to the N.-N.-E. The copper ore is accompanied by iron pyrites which are occasionally found in the pentagonal dodecahedron form, but most commonly in such irregular and anomalous forms as can with difficulty be described. There are a few specimens of grey copper, but the working ore is undoubtedly pyrites. On visiting the mine in 1836, Captain Drummond found the lode about two feet wide, containing a good yellow copper ore, but with a large proportion of its matrix talcose, twenty per cent. only being metalliferous. The ore is extracted in the usual way by means of drifts slightly inclining upwards, to allow for drainage. The adit at Captain Drummond's visit was driven on the course of one of the lodes which continues west about 60 feet, when it falls in with another lode that alters its direction to 15,° and afterwards to 30° north, inclining nearly 50° to the east of north. At that time the adit had penetrated some 348 feet from the entrance. The ore had been taken away from beneath as far as the miners could excavate it, and the hollow had been filled up with rubbish. From above, too, the ore was taken away as far as it was found productive. The passage varied from two to four feet in height and from two to two and a half feet in width, being bounded by the hard dolomitic rock which the miners did not know how to remove. In 1868-69 these mines fell in and became flooded with water. About a couple of hundred yards to the north, and in the same hill, is another similar deposit of copper. This used to be laid open to the surface during the rainy season, and was then allowed to fall in, so soon as the water employed by the miners to carry off the talcose mud from the ore ceased to be plentiful. This also has ceased to be worked for some time.

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[1] Lawder in Rec. Geol. Sur.

Ore assayed.

In 1815 one specimen of fused copper from the Gangoli mine and several specimens of the ore in matrix were sent to the Mint at Calcutta for assay. The report showed that the ore was mixed with arsenic and sulphur, and produced 25 per cent. of malleable metal, but the specimens were too small to allow of any exhaustive examination of them.[1] In 1826 Captain Herbert valued the outturn at 35 per cent. of the pure ore, and in 1836 Captain Drummond gave the general result from the pyrites in their perfectly pure state as about 30 per cent. of metallic copper.[2] Pyrites, though not a rich ore, is the most important of any, from its abundance and from being generally more to be depended on for continuance than the richer varieties. In England more copper is obtained from it than from all the other ores together. The Gangoli, Síra, and Sor mines were farmed from the conquest until 1828, when they were leased for one year to the miners,[3] and were again farmed at a reduced rent in 1833. In 1815 they yielded a revenue of Rs. 850, increased to Rs. 1,201 in 1819 and 1820, and to Rs. 1,215 in 1821 and 1822, but in 1874 the whole of the copper mines of Kumaon brought in a revenue of only Rs. 30 a year.

Síra mines.

The Síra mines in Patti Bárabísi in pargana Síra are situated on the northern side of a hill somewhat higher than the one at Rái. The ore here too consists of copper pyrites, accompanied by iron pyrites in a gangue formed of dolomitic and talcose rocks. In 1816, a specimen of copper ore from the Síra mine was sent to the Mint at Calcutta for assay, with the result that it was found to contain only 24 per cent. of malleable metal, so that it was thought that this mine would not repay the working.[4] Captain Drummond found that nearly thirty-three fathoms from the entrance the adit struck on a copper lode on which a level passage was driven that continued westward, its course being about 10° south of west, and the dip northerly from 45° to 50°. The ore was harder and more mixed with iron pyrites than the ore at Rái. At the end of the level a second lode yielding a poor ore was met, and beyond it a pit was sunk which seemed to have yielded in former times fair returns.

Gaul : Sor Gurang.

The Gaul mine in Patti Kharáhi and the Sor Gurang are similarly situated, but the ore produced is in very small quantities, consisting of grey copper, copper pyrites, and carbonate of copper. Steatite and limestone are the neighbouring rocks, the steatite forming the gangue. The Sor mine had not been worked up to 1833, although a lease at a small rental had been taken out in 1821.[1] Captain Herbert notices that all these ores are free from the presence of arsenic, which, above all other metals, deteriorates the quality of the copper and is most difficult to remove.

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[1] To Government, dated 14th June, 1815. From Government, dated 18th January, 1816.

[2] See further Stat. Kum., p. 359 : J. A. S. Ben., VII., 935.

[3] To Board, dated 2nd January, 1829.

[4] From Government, dated 18th January, 1816.

Bournonite.

In digging the foundation of a house at Hawalbágh the workmen came on a vessel containing three crystallized specimens of bournonite, the triple sulphuret of copper, antimony, and lead, and the only trace hitherto discovered of its existence in these hills (1826). Copper pyrites also exist near Ganai and Phadiáli in Patti Athgáon in pargana Gangoli; at Bujúl and Rathráyat in Patti Bel in a matrix of steatite and feldspar; and at Támba kán in Patti Gangoli in a matrix of talcose rocks. There are small mines in Patti Giwár, at Chín ka Káli, Beler, Sor, and at Kemakhet, on the east bank of the Ladhiya river in Káli Kumaon.

Copper mines of Garhwál.

The copper mines of British Garhwál are more extensive and have always borne a higher reputation than those of Kumaon. The principal are situated at Dhanpur and Dhobri in pargana Dewalgarh. These mines yielded a considerable outturn in former times, but of late years operations have not been so vigorously carried on, owing to the intricacy of the workings, and the idea prevailing among the miners that very little ore remains in the mines.

Dhanpur mine.

The Dhanpur mine is situated on the north side of a high and precipitous range in compact dolomite.[2] The ores are principally copper pyrites and grey or vitreous copper ores, with the red oxide and green carbonate in smaller quantities, the latter being scarce. The ores are found in a bed about fifty to sixty feet wide, which runs nearly north and south, and underlies east about one foot in the fathom. It is divided by a bed of potstone or indurated talc, which runs through the copper formation longitudinally, conforming to the strata and having a frith or flukan on the western side. The seams of ore are sometimes one foot in thickness, but seldom more than one inch. In his report on Dhanpur, in 1816, Mr. Traill declared that these mines were incapable of much improvement, and that the ore produced was not rich. The lease of the mines, including the twenty-two villages attached to supply the requisite labour and grow grain for the miners, was fixed at Rs. 1,850 a year. Up to 1829 there was little improvement, as the lessees were too poor to undertake the cleaning out of the mines, and no capitalist would venture to take them.[1] In 1838, the best seam or vein seen by Mr. Wilkin was not more than half an inch thick, and in 1841 the best lode worked was about two inches. The veins are very close together, and being softer than the matrix, the ore used to be first removed, and then the miners burned the rock with wood and threw water on it to facilitate removal. The red dolomite is of such a consistence as to seldom require props for its support, thus enabling the miners to dispense with wooden framework and to work all the year round, while the situation of the mine on the top of a hill admits of adits for drainage. The interior consists of a network of chambers from end to end.

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[1] To Board, dated 14th February, 1829.

[2] Mr. Wilkin's report, J. A. S., Ben., XII., 454 : Beckendorf's report. *ibid*, XIV., 471 ; Captain Herbert to Commissioner, 10th January, 1826.

Dhobri mine.

The Dhobri mine is situated on the south side of the Dhanpur range in very nearly the same kind of rock as the Dhanpur mine, but in this mine most of the veins are horizontal, running along the side of the hill. At the surface they are very small, containing oxide of iron and green stains of copper, and occasionally copper pyrites. The present working mine is not extended very far from the outside of the precipice or surface, the ores being much the same near the surface as at a distance from it. When the miners find their passages growing long and tedious they begin outside on a new vein. There are several old mines west of the Dhobri village; one of them is very extensive, and the ores seem to have been most abundant when the horizontal vein was crossed by perpendicular ores; but the whole of the horizontal vein has been taken away. The most western of these veins is said to have been very rich, but it fell in about the time the Gorkhális entered the province, and has not been opened since. The ores of these mines are principally copper pyrites, containing 25 per cent. of copper. There is water for machinery about a mile and a half below the mine, and wood for all purposes near that place. There is another mine on this range at Maulgiri, said to be in the same rock as the Dhobri mine. There are other mines of both copper and iron in Dhanpur, but few of them are worked, and they are for the most part of little value. The mines were leased in 1872 to a European, but even then western intelligence and energy could not make them a remunerative investment. There is a copper mine in Patti Lobha at Agar Sera[1] in the face of a precipice on the right bank of the Rámganga river which was leased in 1872 for three rupees. The lessee, however, makes little profit, as the shafts have been sunk so deep that men are afraid to enter them, and the rock is too hard to allow of fresh shafts being driven, unless at great expense.

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[1] To Government, dated 14th February, 1829.

The Pokhri mines.

Chaumattiya mine.

The Pokhri copper mines early attracted the attention of the Government of the country. For many years they had been worked by the Garhwál Rájas, and subsequently by the Gorkhális. They consist of several separate mines; that known as the Chaumattiya is situated in talc which rests on dolomitic limestone. The lode after crossing the ridge east of the mine enters a very compact basin, in which is situated the Duined mine. This has not been worked much, owing to the softness of the talc and the abundance of water, but it is said to have a good lode in one part of it. The lode then crosses the hill near Deothán, a small village above the mine, and is found near Gúgli and Keswara, where some ores have been extracted, but have never proved very profitable in working.[2]

Rája's mine.

The Rája's mine is situated about 450 yards north of the Chaumattiya mine in common dolomite which rests on talcose schist. A shaft of 70 fathoms was dug by the early workers meeting an adit which must have been driven over 100 fathoms through dead ground. Several other adits were driven, and when they fell together, about one hundred years ago, there were three places where copper was found—the Gaja Chauk, Kuvera Chauk, and Bhartwál Kúa, all of which have now fallen in. The produce was about 300 sers of ore a day, yielding 25 per cent. of copper. Two-thirds were claimed by the Rája, and the remainder was left to the miners, who had also grants of land free of revenue. The experiments of Mr. Wilkin already noticed were confined to these two mines and a new mine which he opened close by. In the new mine the lode was very promising and yielded good specimens of ores near the surface, but at a depth of fifteen fathoms it became poor, and was consequently abandoned. During the time the experiment lasted the expenditure on the Chaumattiya mine amounted to Rs. 2,847, and the return in copper to Rs. 231, besides about three to four hundred rupees worth of ore. Rs. 347 were expended on the Raja's mine, and the experiment was then abandoned, and the new mine cost Rs. 246 before the operations were closed. The entire net cost of the undertaking when operations ceased was for labour, in working the mines, less sale proceeds of copper, Rs. 2,585, and for European superintendence Rs. 4,800, or a total of Rs. 7,385. These mines were then leased to a native contractor for Rs. 500 a year.

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[1] Described by Beckett in Sel. Rec., N.-W. P., III., N. S., 371.

[2] For details of these mines see Mr. Wilkin's report in J. A. S. Ben., XII., 454, and Beckett's [illegible] in *ibid*, XIV., 471.

In addition to the three mines mentioned above there are several others in the vicinity of Pokhri, some of which were worked by the former rulers, and some again have never been opened. Mr. Wilkin noticed the principal mines, and described them as follows:—

Nota mine.

The Nota mine is situated about two and a half miles north-west of the Pokhri mines in talc, which rests on dolomitic limestone. The lode is a bed of yellow or buff-coloured talc, about four feet wide, dipping north-west at 50°; it rests immediately on the dolomite limestone, and has a sulphuric effervescence on the surface. This mine is said to have been rich; it is situated on the western side of an extensive basin or valley, on the eastern side of which ores have been turned up by the plough, but no mine has been worked. This is an extensive field for mining, as the lode may be productive throughout the basin or valley. There is wood and water for all purposes near this mine.

Thála mine.

The Thála mine is situated about a mile north-west of the Nota mine, probably on the same lode, in an extensive plain or comparatively level surface. It was first worked in 1810, and again in 1825, but there being no good facility for adits, the water prevented its being worked to any considerable depth. The miners who worked it state the ores to be copper pyrites disseminated in a lode of two feet wide, one-fifth of which was metalliferous. There is plenty of wood for all purposes in the neighbourhood of this mine.

Danda mine.

The Danda mine is situated on the hill, about 500 yards above the Thála mine, in chlorite slate and talc, which on the north-western side comes in contact with common dolomite. This mine has been worked to a considerable extent, and is said to have yielded Rs. 52,000 profit in one year. The ores are of good quality, and found in three or four different beds or holes which dip into the hill at an angle of 30°. The chlorite slate in which the beds of talc and ores are found is so hard as to stand without timber ; it also contains finely disseminated copper in small quantity. The lodes run into a fine fall or basin westward, in which Mr. Wilkin thought they would be found productive. There is abundance of wood near this mine, but no water for machinery nearer than the Thála mine.

Tálapúngla mine.

The Tálapungla mine is situated about a mile north-east of the Danda mine in talc, which rests on dolomitic limestone. The strata in which the ores are found is about six fathoms wide, dipping south-west at various angles. The bed is extensive, but the ores are scarce ; however, this might improve at a distance from the surface. Ores have been found in a precipice, east of this mine, near the village of Bangtál, but at present the outcrop is covered with rubbish ; it is in the talcose formation, and has good facilities for working.

Kharna mine.

The Kharna mine is situated in the ravine below Bangtál, near its junction with the Nágal river in talc ; it was discovered by the water of the ravine washing away the strata, and leaving a quantity of ores exposed to view ; these ores were taken away by the Pokhri miners and the mine was worked five or six fathoms under the surface, beyond which they were prevented from going by the water. They say that the lode at the bottom of the mine for two fathoms in length is one foot wide, of solid copper pyrites. Of late years nothing has been done at this mine beyond washing among the surface layer, which contains a small quantity of copper pyrites. There is plenty of wood in the neighbourhood of this mine and water for machinery, but no facility for adits.

Mr. Beckett has described the mode of mining and preparing the ore of the Agar Será[1] mine from which the following account has been extracted. The gangue consists of white and yellow quartz much encrusted with green carbonate of copper, and is so difficult to work that not more than 40 to 60℔. of ore can be excavated by one man in a day. The workings are dry and the lode has a dip of about 30° below the horizon with a north-westerly direction. The ore is pounded and moistened with water and receives an admixture of five parts in six of limestone as a flux. The charge, consisting of about 6℔. of unmixed ore, takes about half an hour to melt and is placed from time to time in handfuls on the furnace, and covered with oak charcoal which is occasionally moistened with water. When the fire falls in after the last supply of ore, the charge is ready to be taken out. The door of the furnace is then taken away and the remains of the fire being raked out, there appears at the bottom a melted mass which, after being stirred about a minute or two to allow the heavier particles to settle down, is sprinkled with water to harden the surface. Three or four of these charges being taken away, the melted copper is found at the bottom in a small mass weighing about $2\frac{3}{4}$ ounces, for which twelve pounds of charcoal have been used. Thus from every 100 parts of ore about $2\frac{1}{16}$ths parts of copper are procured, having consumed 200 parts of charcoal or, in other words, 137℔. of charcoal are required for the production of a little over two pounds of pure copper, which sells at about one rupee a pound.

Iron mines.

The iron ores found in Kumaon all belong to either of two varieties, the rhombohedral or the prismatic. The first is a peroxide of iron containing in its best defined type 70 per cent. of iron and 30 per cent. of oxygen. The workable ore, however, often contains earthy impurities which reduce the proportion so low as 50 per cent. of metal. This is the common species. A variety of this, known as red hæmatite, also occurs in many places, and frequently contains small grains of specular iron ore of a highly splendent lustre. At Rámgarh it passes into the variety known as scaly iron ore, consisting of loosely cohering glimmering particles of a steel-grey or iron-black colour, strongly soiling and feeling unctuous to the touch. Captain Herbert considers these beds connected with those at Dhaniya Kot on the Kosi. Both yield very good iron. The prismatic species or hydrated peroxide is only known to occur in the Chaugarkha pargana.

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[1] See Sel. Rec., N.-W. P., III., N.S. p. 34. and Glenn. in Science. I., 230 ; As. Res. XVIII, (1), 227 (Herbert) ; Traill and Batten, Statistics of Kumaon, Agra, 851.

Kumaon mines.

The following are the principal iron mines in Kumaon. In Patti Agar of the Rámgarh pargana, as noted, the iron is of the species known as scaly, somewhat laminated in structure, slightly micaceous, and influencing the magnetic needle. The names of the principal mines are the Lúgani, Nathúa Kán, Gulla and Satbúnga mines, the last of which has a rich hæmatite. In Patti Rámgarh, also, there are several mines that are largely worked. For the first 18 years of British rule these mines were leased to the headman of the Agaris at a nominal rent,[1] which up to 1826 included all the iron mines in Kumaon. In 1833 the mining industry in Rámgarh received its first check in the emigration of the miners to Khetsári in Páli, and has never since recovered its early importance. In the Chaugarkha pargana, the ore of the Muniya mine in Patti Lakhanpur is of the prismatic species. It is of two varieties, the ochry and compact. The former sometimes contains octahedral crystals and magnetic iron ore, and in the neighbourhood of the mine on the summit of a small hill there occur rolled pieces consisting of grains of quartz and small octahedral crystals of this mineral cemented together. These pieces are magnets, and have each two poles. The ores, too, contain manganese in notable proportion, and would consequently afford a very good steel; as it is to the alloy of this metal that the superiority of the steel manufactured from brown ore is attributed. In Patti Dárun there are mines at Digarhia and Jhiratoli of the same nature; in Rangor Patti at Jalal and Digarhia; in Patti Kharáhi at Lob. A specimen of iron ore brought from the neighbourhood of Milam, called by the natives of Malla Juhár '*buldúnga*,' seems a crystalline variety of red hæmatite. It is used there for a red dye, the colour being extracted by rubbing the stone on a hard surface while wet.

Giwar mines.

The mines of Patti Giwar in pargana Páli are found at Chiteli, Sirauli, Khetsári, Simalkhet, Gudi, Bailgaon, Bonigarh, and close by at Mehalchauri and Tilwára. The valley in which the iron is produced runs nearly north and south, and extends from Dwárahát on the south to Pandúa

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[1] To Government, 24th December, 1833.

Khal on the north. It is formed by the rivers Kotlar and Khetsári, both flowing into the Rámganga, the bed of the former being about nine miles long, and that of the latter six miles. The ores lie on the east side of the valley and occur along a range of hills about thirteen miles in extent. The Simalkhet mine[1] is the largest, and has four entrances penetrating upwards of 350 feet into the mountain. The ores here consist of red hæmatite of a good quality in a gangue of clay slate branching in every direction and at all angles. The lodes range from 3′ to 18′ in width and 2½′ to 15′ in height, the average being from 3′ to 5′ by 4′ to 6′. There is no water, and the surrounding rock is compact, requiring few supports.

In Sayalgarh of pargana Kotauli there is some iron ore not at present worked. At Manglalekh in Talla Rao the ore is much esteemed for its quality, and is raised in some quantity. At Debchauri, Rámgarh, and Khurpa Tál the mines are in the hands of the Kumaon Iron Works Company. The Lugthan mine is in Malla Katyúr, and there is another in Baraon Patti in pargana Gangoli. The burrows at Khairna are now unworked, likewise those at Simalkha and Uchakot.

Garhwál iron mines.

In the Garhwál district the iron mines in Patti Painkhanda exhibit specimens of granular iron pyrites imbedded in veins of quartz which occur in a dark-greyish talcose schist. They are apparently not very rich in ore. In Patti Síli Chandpur the Rajbúnga mine gives a rich hæmatite which is slightly attracted by the needle, and is still worked. The Khúsh mine in the same patti gives a micaceous ore, scaling off easily and showing minute crystals resembling garnets on the edges of some specimens. The adjacent beds seem to be chloritic schists; this ore affects the needle. In Taili Chandpur magnetic ore is found with hæmatite, and a specimen from Patti Talli Kálíphát resembles specular iron ore.

Nágpur mines.

Specimens from the Búkhanda mine in Patti Bichhla Nágpur are also of a micaceous nature, and seem to contain in parts minute crystals of quartz and pyrites, otherwise they much resemble graphite, and soil the fingers when touched. They do not influence the compass needle. The Jákhtoli mine in the same patti give an ore which is probably a clay ironstone. It is of a light coffee colour and of little specific gravity. The Gílet mine close by gives an ore of a similar quality. In Malla Nágpur the ore is probably hæmatite. A vein of iron pyrites runs along the Alaknanda in this patti near the village of Hath. The people call them '*sona ke puthar*,' or gold stone, and sell them to the pilgrims to Badrináth at high rates. The stones, in the form of powder, are used as an orpiment, and the stone itself as a flint. A specimen from Nágpur itself is probably a carbonate of iron.

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[1] III., Sel. Rec., N.-W. P., 23.

Dasauli and Bachhansyún.

The Mok mine in Patti Malli Dasauli yields an ore of which specimens appear to be magnetic, rich in metal, black in colour and crystalline, and laminated in structure. It possesses highly magnetic properties. The Charbang mine in the same locality is of a similar character, very rich in iron, and, according to Mr. Lawder, exhibits its polarity in the direction of the planes of lamination. The Dúngara mine in Patti Bachhansyún gives specimens which may possibly be an earthy hydrated oxide of iron. Its colour varies from ochry to dusky black, streak the same. It is of little specific gravity, the clay seemingly predominating. The iron of Bachhansyún, however, has a wide reputation for hardness and toughness. Sledge-hammers (*gan*) made from it have been found to last out those of the best English metal.

Iriya Kot.

The ore of Pípali mine in Patti Iriya Kot is probably a hydrous form of sesqui-oxide of iron, the clay largely predominating. The Danda Toli mine in the same patti seems to give an argillaceous variety of brown hæmatite. Lohba affords a rich hæmatite, raised in large quantities. The Chalya mine in Patti Painún gives a hard and brittle ore possessing the iron-black colour and metallic lustre of magnetic iron, but specimens of it failed to affect the compass needle in the manner characteristic of that ore. It may possibly on analysis be found to contain manganese.

Lead.

The deposits of lead are fairly numerous. The ore is found at Táchhíra in pargana Dhanpur mixed with a little silver. A large mine also existed at Ghirti in the snowy range between Milam and Níti, but this has lately been closed by a landslip. The mines at Ralum and Banskum on the banks of the Gori river and at Baidli Baghu are unworked. The ore is galena, and the matrix is silex, with varying proportions of feldspar and calcspar. The Nágpur mine is a fair one, but somewhat inaccessible. Near the Gaul mine in Patti Kharáhi and at Sor Gurang copper mines there are deposits of lead ore. The former is a galena traversing a silicious limestone, but neither are regularly worked. When the villagers require lead they burn the rock, and the lead, more or less sulphuretted, trickles from the crevices. A large nodule of lead, the size of an eighteen-pound shot, was found in Patti Maundarsyún, on the banks of the Nayár river. It consisted of pure galena, but though search was made no more could be discovered. In Jaunsár there are mines at Maiyár and Borela on the left bank of the Tons river and at Aiyár on the right bank. At Maiyár and Aiyár the matrix is clay slate, and at Borela, limestone supposed to be a bed in the clay slate.[1] The revenue from these mines is now nominal.

Arsenic.

Yellow arsenic, known as *haritál*, is found in the northern parts of Kumaon, near Múnsyári. A small portion is brought down every year by the Bhotiyas for sale at the Bageswar fair in January.

Lignite.

Indications of lignite appear near Ránibágh close to Haldwáni, the Barakheri pass near Bhamauri, and in the streams of the sub-Himálaya near Najíbabad in the Bijnor district. They do not give promise of any workable fuel, and, judging from the experience obtained in other parts of the hills, it is questionable whether any lignite deposits will ever be discovered of such extent and quality as to repay the expense of mining them. An analysis of a specimen of the Ránibágh lignite gave carbon 60·0, volatile matter 36·4, ash 3·6. The percentage of ash, however, contrasts favourably with Bengal coal.[2] Traces of a true peat are found at Bhím Tál. In 1833 Mr. E. Ravenshaw reported[3] the existence of coal in the bed of the Dhela river near Láldhang in Garhwál, where it occurred in thin seams varying from one inch to four inches broad. Similar traces were discovered in the beds of the Chala and Phíka streams, but none of any commercial value. The specimens received in Calcutta were nearly all of the same character, "strongly impregnated with sulphuret of iron which forms their fibres, streaking some of them and passes into thick masses of pyrites, decomposing in others. A clean lump had a specific gravity of 1·968 in consequence, and the residual ash was principally iron oxide."

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[1] Gleanings in Science. I., 230.

[2] As. Res., XVI., 387, 397.

[3] J. A. S. Ben., II., 264.

Graphite.

Graphite[1] (plumbago) crops out at the Kalimatiya hill to the north of Almora and on the spur of Banini Devi facing Almora on the Lohughát road. In 1850, specimens were sent to England and subjected to examination, when it was found that it could be made serviceable as graphite. Excavations were also made by Major Drummond at Garjoli near Balti, and Palsími, about three miles from Balti and the same eastward of Almora. The following is the report of Mr. Rose, the mineralogist who tested the specimens sent from Almora :—"Graphite is applied to several purposes. When very fine, compact, and of a sufficient cohesion, it is cut up for drawing-pencils. When the texture is loose, or it is otherwise of inferior quality, it is ground down and deprived of foreign substances by washing, as ores of metals are prepared for smelting. The powder thus purified is then used for various purposes, such as crucibles (being refractory or infusible by heat) for burning iron, and reducing the friction of machinery. A new method is now adopted for making artificial pencils, which are scarcely if at all inferior to those sawn out of the finest blocks. The dust of such fine material as your specimens Nos. 4, 8, and particularly No. 10, properly prepared, is subjected to vast hydraulic pressure (several hundred tons), and thus acquires the compactness and solidity necessary for the best purposes. The best kinds of graphite may be known by a pale lead-blue colour, high lustre, unctuosity, and inferior specific gravity. The first nine specimens will answer for pencils, most of them sufficiently pure and compact to be divided for that purpose. All the varieties sent may be used, even No. 13, though connected with much matrix, as it can be deprived of this by grinding and washing. All the varieties of this substance must continue in demand and bring remunerative prices if the expense of mining and conveyance should not be too great." It is also found in Patti Lohba of Garhwál on the Karnprayág road, and is there used as a dye.

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[1] See, further, Gleanings in Science, III., 280 ; J. A. S., XXIV., 203 ; In. Rec. (H. D.), XVII., 58 : Rec., N.-W. P., III., N. S., 371.

Sulphur.

Sulphur is found both in Kumaon and Garhwál. In the former district it occurs in the tract called Mún-syári, and mechanically mixed with carbonate of lime in the beds of the Rámganga and Ganjiya rivers. It is also found as green sulphate of iron, and could be obtained in any quantity from the iron pyrites of the copper mines. There are also some sulphureous springs, as those at Naini Tal, Nargoli, and Káthgodám. There are two sulphur springs in Garhwál: the first lies close to the snowy range to the north-east of the temple of Madh Maheswar in pargana Nágpur; the other is on the left bank of the Biri river, two miles above its junction with the Alaknanda. The water of this last is so very strongly impregnated that its existence can be discovered by the smell long before arriving at the spring itself. Neither are made use of any way. Sulphur is also found in the galleries of the lead mines at Maiyár on the Tons in Jaunsár.

Borax.

Borax or tincal, a native saline compound of boracic acid and soda. The borax and salt fields of Gnari or Húndes, *Ihá-Ihaka* or *Ibáli-Ihákа*, lie to the north of Bongbwa Tál, across mountains that round the north-east side of the valley of the Shajan river, parallel to the Gangri range, and in the eastern part of the Zjang of Rohtoh (Rudukh) and at the Chapakani lake. The two salts are obtained from different spots in the same vicinity, and are both worked in the same way by lixiviation from the earth taken from the surface of the ground in which the salts are developed by natural efflorescence. These salt fields are open to all who choose to adventure their labour in them on payment of one-tenth of the produce to the Lhassa Government, who have an excise establishment on the spot.[1] The borax is collected from June to September and sold at the different fairs—Ganpa, Gartoh, Sibilam, Chájna, Taklakhar, Dabakhar. It is brought down by the Bhotiya traders and purchased by the merchants of Rámnagar, where it is refined. The process is as follows:—The borax is pounded and placed in shallow tubes, and then covered with water to the extent of a few inches; to this is added a solution of about two pounds of lime dissolved in two parts of water, for every ten maunds (820 pounds) of borax, and the whole mass is well stirred every six hours. Next day it is drained on sieves or cloth, and after this is again dissolved in 2½ times its weight of boiling water, and about sixteen pounds of lime added for the above quantity. It is then filtered, evaporation takes place, and subsequently it is crystallized in funnel-shaped vessels, usually of *kansa*, an alloy of copper and zinc or lead. The loss in weight is about 20 per cent. Borax is used in medicine and the arts. Dry borax acts on the metallic oxides at a high temperature, melting and vitrifying them into beautiful coloured glasses. It is also used as a flux for soldering in goldsmith's work and as a varnish combined with shell-lac. Its principal use is, however, in the manufacture of coloured glass, enamel, and glazed substances.[1]

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[1] Strachey: J. A. S. Ben., XVII. (2), 57.

Gypsum.

Gypsum is found in pargana Chhakháta. Perhaps the best bed is near the Nihál bridge on the road between Káládhúngi and Naini Tál. In 1850 the late Mr. Tregear, of the Bareilly College, made some very good plaster of Paris from it, which might be found useful in external plastering, as it has the property of expanding on cooling. Gypsum is found in Garhwál, on the banks of the Alaknanda near Panai and Nagrasu. There is also a dark-green variety which the people sometimes make into saucers and bowls.[2] Captain P. T. Cautley noticed[3] the occurrence of gypsum at Sansardhára and Salkot near Dehra and described its appearance and origin, which was further discussed by the Rev. R. Everest, but these papers have now little practical value.[4]

Soapstone.

A white saponaceous stone resembling and used for the same purpose as pipeclay is produced in many places. In Garhwál various vessels are turned from it, which when polished have the appearance of marble. They retain liquid, but being extremely brittle are little used.

Asbestos.

Asbestos has lately been discovered in a hill to the north of and at a short distance from Ukhimath in Garhwál. It is said to be of very good quality, but it is too far inland to be profitably worked. The people use it medicinally for dressing wounds and burns, and as a wick for oil-lamps, but it may yet be turned to a profitable account as a packing for steam-joints and the like.

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[1] Ure, I., 881. [2] As. Res. XVIII. (1). p. 216. [3] J. A. S. Ben., I., 289. [4] *Ibid*, 430, and Sherwill on Darjiling gypsum, *ibid*, XXI., 538.

Silajit.

Silajit[1] or *Salajit*, a native sulphate of alumina, is found both in Kumaon, Nepál and parganas Painkhanda and Nágpur in Garhwál. It is much sought after and used as a dressing for wounds. It occurs in small light lumps, colour brownish white, externally anhydrous, internally semi-crystalline, fracture slightly fibrous, with a lustre resembling asbestos, porous, containing small cavities lined with scarcely perceptible needle-like crystals, adheres a little to the tongue. Taste acidulous saline, soluble in twice its weight of distilled water, friable. Mr. Stevenson's analysis[2] gives as its component parts: sulphate of alumina, 95; peroxide of iron, 3; insoluble matter (silex), 1, and loss, 1. This analysis would appear to point to a specimen of greater purity than those commonly met with in the bazars which, as a rule, have seldom more than 66 per cent. of sulphate of alumina. The lumps generally have an admixture of red sand and frequently portions of micaceous stone are found embedded in them. Some of them have the smooth surfaces of stalactites and are not unlike those deposits. All are readily soluble in water, and when touched with the tongue give the taste of common alum. Dr. Campbell has described[3] the Nepálese trade in Salajit.

Limestone.

Limestone is found all over the division, both in immense masses exhibiting various shades of colour and structure, and as local tufa deposits. There are three distinct ranges of limestone hills in Garhwál: the first north of the Alaknanda in Nágpur, the second running from Lohba Patti to the Pindar, and again to the Alaknanda in Patti Bachhansyún, and the third running parallel to the plains and south of the Nayár river. There are also small patches of limestone scattered throughout the district, but not in such large quantities as in the abovementioned ranges. Lime is manufactured at Naini Tal, at Jyúli in the Kharáhi range, half-way between Bágeswar and Almora, at Chiteli, north of Dwárahát, at Simalkha, Baitálghát, and Dhikuli for Ránikhet, and on the new cart-road to Rámnagar. Lime is also made in Boraráu, Sor, Síra, Dhyánirao, and Charál. Two kinds of limestone are used in the Tarái district, the one being obtained from the quarries at the foot of the Kumaon hills, which give by far the best kind of lime; the other is the tufa deposit obtained in the small nálas of the tract itself; this latter kind, however, is of a very inferior quality. First-class limestone costs at the quarries five to eight rupees per 100 maunds; the tax levied by the Forest Department is eight rupees on that amount, and cartage may be averaged at half a rupee per mile for 100 maunds. Thus the stone is landed at most points in the district for 30 rupees per 100 maunds, and including the expense of burning, a maund of lime costs 10 to 12 annas. This lime will bear two or three portions of pounded brick or *surki*. Second-class lime ready for use now costs 25 rupees, and delivered in Naini Tál, 50-100 rupees per 100 maunds; it will, however, only bear a proportion of one part of pounded brick to two parts of lime.

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[1] Derived from '*sila*,' a stone, and '*jit*,' principle or essence.

[2] J. A. S., Ben., II. 321.

[3] J. A. S., Ben., II., 482.

Building stone.

Good building stone can be procured in most parts of the hills. At Almora fine-grained, evenly-bedded quartzites and mica-schist form the hill itself, and supply material not to be excelled for durability and facility of dressing. Mica-schist seems to form the principal beds for some distance to the east and west of Almora, reaching to Dwárahát and Mási on the west, Páli, Ránikhet, Síyáhi Devi, Dol, and towards Káli Kumaun to the east, and also in the formation of the Jageswar and Binsar ranges to the north. At Naini Tál the stones used are limestone and clay schist. At Ránikhet a pale-coloured gneiss forms both a handsome and a lasting building stone having the property of hardening by exposure. Sandstone is abundantly found in the lower hills. Gneiss and chlorite-schists are used frequently as building stones in the district. In the Bhábar split boulders are found to answer the purpose of bricks. The Tarái is the only portion of the Kumaon division where bricks are extensively used for building purposes. Nine-inch bricks cost about Rs. 750 per lakh, and the small native bricks Rs. 100. Stone is sometimes carted from the foot of the hills for the better kind of work, but owing to the great expense is, so far as possible, dispensed with.

Roofing slate.

At Chiteli near Dwárahát there are roofing-slate quarries, now unworked; also at Dhári in the Bel Patti of Gangoli; in Bორarao Patti, Sult Patti, and at Naini Tál. In Lohba of Garhwál the thin dark-blue slate is procurable, but these last appear to be much inferior to the Chiteli quarry.

Alum.

Alum, known as *phitkari*, is found in different parts of the province, and in abundance in the aluminous shales near Ják village, on the road from Naini Tál to Khairna and as an efflorescence on the micaceous schist in the bed of the Kosi below Almora. The shales contain minute particles of pyrites disseminated throughout their mass, which on becoming decomposed promote the formation of alum and the lixiviation produced by water leaves an encrustation of alum on the rock. A dark-coloured talc called *jalposhi* is exported to the plains and used as a tonic and febrifuge in medicine. In the neighbourhood of Kotgaon and Giwarsiu near Paori in Garhwál a bitumen or mineral resin is found.

There is no doubt but that in both quantity and quality the metalliferous deposits in this division are good, but the absence of coal and the competition of sea-borne metal have hitherto rendered mining an unproductive speculation, nor does there seem any probability of it attaining any important position among the industries of the province.

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CHAPTER VII.

SCIENTIFIC BOTANY.

CONTENTS.

A list of the *flora* of Garhwál. Jaunsar-Báwar and the Dehra Dún, by Dr. King. Tract to which the list refers. The Siwáliks. Sub-Siwálik tract. Dehra Dún. Himálayan tract. Characteristic vegetation from the plains to Mussooree. From Mussooree northwards. A list of the *flora* of Kumaon, and the Kumaon Bhábar, by Dr. Watson.

LIST[1] OF THE PLANTS OF GARHWÁL, JAUNSÁR-BÁWAR AND THE DEHRA DÚN.

Tract to which this list refers.

THE tract of country of which the vegetation is to be considered in the following pages presents very varied conditions in respect of physical configuration, soil, and climate. Its boundaries are—on the west the river Tons, a tributary of the Jumna, and on the east the Bhágirathi branch of the Ganges; on the north the snowy range of the Himálaya, and on the south the Siwálik range.

Siwáliks.

The Siwáliks run parallel to the Himálaya, and are separated from the latter by the Dehra Dún, a flat valley having an elevation of from 1,800 to 2,250 feet above the level of the sea. The highest peaks of the Siwáliks do not rise much above 3,000 feet, and the majority are much lower, but their outline against the sky is jagged and picturesque in the extreme, and the part of them with which we have to deal is about seven miles wide. Their southern slopes are ploughed by the force of the south-western monsoon into numerous deep narrow valleys, and the steeply scarped cliffs have a singularly bold beauty, totally different from anything to be seen in the outer parts of the Himálaya behind them. On their northern aspect, the Siwáliks slope gently into the valley of the Dún, and the scenery, though beautiful, is tamer than on the southern side. The rainfall on the range during the south-west monsoon is about 60 inches, but from the porous character of the soil and the steepness of the slopes, water drains off with extraordinary rapidity. The drainage passes away by innumerable channels, which, except for a few days in the year, are wide wastes of dry gravel and boulders. After each heavy shower these suddenly become filled with rushing torrents, which subside as speedily as they rose. Except during the rainy season, the range is very dry, and water is so scarce as to make it almost uninhabitable.

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[1] This list has been kindly prepared by Mr. G. King, M.B., F. L. S., Director of the Royal Botanical Gardens, Calcutta, for this work.

Sub-Siwálik tract.

Where the Siwáliks merge into the plains on the southern side, there are tracts of forest and grass equivalent to those covering the Bhábar and Tarái of the Himálaya in the districts where there is no Siwálik range. The vegetation of the sub-Siwálik belts is to a great extent but a reproduction in miniature of that of the latter. The flora of the southern face of the Siwáliks comprises many plants of the plains, with the addition of such species as *Hypericum cernuum* and *Cochlospermum Gossypium.* Perhaps the most striking tree found in the Siwáliks is the long-leaved pine *(Pinus longifolia)*, a Himálayan species, for which the Siwáliks form an outlying station. A large proportion of the arboreal vegetation of the Siwáliks consists of species which occur both on the lower slopes of the Himálaya and on the hilly districts of central and southern India, thus affording a good illustration of the width of distribution of Indian plants. As examples may be mentioned *Bombax malabaricum*, *Buchanania latifolia*, *Spondias mangifera*, *Boswellia serrata*, *Garuga pinnata*, *Spatholobus Roxburghii*, *Albizzia stipulata*, *Anogeissus latifolia*, *Ulmus integrifolia*, and others. Epiphytal orchids are absent, and ferns are but few in the Siwáliks. One labiate plant *(Eremostachys superba)* is confined to one or two spots in the Siwáliks, and is one of the best examples known to me in India of a truly local plant. Sál *(Shorea robusta)* of very stunted growth is abundant in the southern sub-Siwálik tract and on both sides of the range, as also over the whole of the Dún. This tree is here near its western limit; a little way to the west of the Jumna it disappears altogether.

Dehra Dún.

The Dehra Dún is a charming valley. The Siwáliks on the south shut it in from the plains, and, until recently, not only most effectually protected it from the hot winds in summer, but gave it a higher winter temperature than the plains outside. The extensive and ruthless clearances of the Siwálik forest of recent years are, however, believed (and apparently with good reason) to have caused an increase of the summer temperature of the Dún. The soil of the Dún consists chiefly of sandstone débris washed down from the Himálaya. The drainage is excellent, especially near the base of the Himálaya where the larger débris has been deposited, and the water level is everywhere far below the surface. The drainage water passes off by the Asan into the river Jumna, and by the Son and Súswa into the Ganges. The watershed of these streams runs across the valley in the line of the station of Dehra. The rainfall is about 80 inches, but, although only a small proportion of this total falls during any other than the rainy season, vegetation is kept wonderfully green during the whole year by the moisture prevalent in the atmosphere. Formerly the greater part of the Dún was covered by forest, of which the prevailing tree was *sál*, but of late years much of the forest has disappeared. A certain proportion of the cleared land has been devoted to village and some to tea cultivation, but much of it has been invaded by tall, coarse grasses useless alike to man and beast. Like the Siwáliks, the Dún is ravaged every hot season by fires from which the arboreal vegetation suffers to a degree which can only be appreciated by one who has lived in the forest. Unless these fires are checked with a high hand, the utter destruction of all forest vegetation in the Dún is but a question of time. The flora of the Dún presents an interesting mixture of species common on the plains outside, and of plants from the lower hills. Notable amongst the latter are the pretty little *Gentiana pedicellata*, and in the rains, here and there, *Platystemma violoides;* whilst amongst shrubs and climbing plants *Lespedeza*, *Indigofera pulchella*, *Jasminum pubescens*, and *Combretum decandrum* are perhaps the most noteworthy. The dense canebrakes of the Tarái and Bhábar of the trans-Gangetic sub-Himálayan tract are represented in the Dún by a few patches of a single species *(Calamus Royleanus)*, and this is not found westward of the Nálapani swamp, three miles from the station of Dehra. Epiphytal *Scitamineæ* are unknown in the Dún: a few orchids, however, occur, the most prominent among which are *Aerides affine* and *odoratum*, *Saccolabium Gharwalicum*, and *Oberonia iridifolia*. *Peperomia reflexa* is found here and there on trees in damp spots, and there are some epiphytal ferns, such as *Polypodium lineare*.

Himálayan tract.

The remainder of the region under review consists of a large irregularly shaped tract of the Himálaya proper, narrowed at its southern limit, but expanding towards the snowy range, part of which it includes. The physical features of this area are so varied that it would be out of place to attempt to describe them here. It must suffice to remind the reader that, while the lower and outer ranges have a climate not very different from that of the plains of India, the higher peaks, rising as they do to 18,000 feet above the sea-level, are covered with perpetual snow. As regards vegetation, the tract may be divided into three zones: the *sub-tropical* covering the slopes of the lower and outer hills, and following the courses of the deep hot valleys far into the interior of the range; the *temperate* covering the middle elevations; and the *arctic* confined to the greater heights and bounded on the north by the snow line itself. The transition between these zones is gradual. In consequence mainly of its greater distance from the sea, the rainfall of the western Himálaya is much less than that of the eastern part of the chain. But not only does the climate steadily increase in dryness from east to west, but the rainfall on the outer ranges is much heavier than in the interior. At Mussooree, for example, it amounts to about 80 inches, while at Harsíl, in the northern end of the Bhágirathi valley, the rainy season is represented by a short period of misty weather, and actual showers are but rare. The intervening country has a rainfall graduated between these two extremes.

Characteristic vegetation from the plains to Mussooree.

In ascending the Himálaya from the Dún to Mussooree, new species meet the eye step by step. Among trees, *Bauhinia retusa*, *Engelhardtia Colebrookiana*, *Rhododendron arboreum*, and the Oaks are the most striking new forms. *Pinus longifolia*, already met with on the Siwáliks, becomes abundant. Berberries, various *Bœhmerias* and other *Urticaceæ*, *Hamiltonia*, *Leptodermis*, various species of *Viburnum*, *Clematis* and *Rosa* at first mingle with, and finally replace, the sub-arboreal woody vegetation of the base of the hills. During the rains the change in vegetation, as one ascends, is even more striking. On steep banks and faces of rock by the roadside the eye is delighted by such charming species as *Chirita bifolia*, *Didymocarpus aromaticus* and *macrophyllus*, *Platystemma violoides*, *Selaginella Jacquemontii*, *Androsace sarmentosa* and *incisa*, *Fragaria indica*, *Saxifraga ligulata*, *Argostemma sarmentosum*, and *Begonia picta*. Ferns too abound both on the ground and on trees. A few epiphytal orchids, the *Peperomia* already mentioned, and *Remusatia vivipara* are found on the trees. But the epiphytal vegetation here is but poor and scanty when compared with that of the eastern Himálaya, thus illustrating in the most forcible way the comparative dryness of the atmosphere throughout the year. On these lower slopes a dwarf palm *(Phœnix acaulis)* and a pretty little bamboo called *ringál (Arundinaria falcata)* are not unfrequent; a larger species of bamboo *(Dendrocalamus strictus)*, which occurs in plenty, is common also in the Dún and Siwáliks.

At the level of Mussooree temperate forms begin to appear and the botanist revels in plants belonging to such familiar European genera as *Ranunculus*, *Thalictrum*, *Anemone*, *Geranium*, *Potentilla*, *Rubus*, *Rumex*, *Pedicularis*, and *Habenaria*. Umbelliferous plants and *Polygonaceæ* are common, and terrestrial orchids of northern forms are not unfrequent during the rains. As the higher elevations are approached, the vegetation assumes the characteristic Alpine type. *Astragali*, *Corydalis* of different species, numerous *Caryophylleæ*, Saxifrages, *Sedums*, Primroses, Gentians and *Carices* abound, and in the carpet of rich green grass are here and there studded the magnificent Aconites, *Meconopsis* and *Pæonia emodi*. Prominent amongst the forest vegetation are the stately cedar, the rigid silver spruce and the graceful weeping pine. The twisted cypress towers aloft, and the solemn yew stretches out its sombre arms. Lichens, mosses and *fungi* abound, and *algæ* are numerous in the streams.

From Mussooree northwards.

The following list of the flowering plants and ferns does not profess to be complete. It contains only the names of species of which there are specimens in the Herbarium of the Calcutta Botanic Garden, or in my own collection. The former Herbarium ought to contain every species occurring within the British Empire in India. It has, however, been brought together principally by desultory private effort, and is consequently unequal and defective. As a rule, there are included in this list indigenous plants only; the few others that occur are marked either as *naturalized* or *introduced*. Certain plants which are believed to be natives, but which are found only in cultivation, are marked as *cultivated*. For much assistance in revising this list I am indebted to Mr. W. Waterfield, C. S.

Natural Order 1.—*Ranunculaceæ.*

Clematis Nepaulensis, DC.
„ montana, Ham.
„ barbellata, Edgw.
„ grata, Wall.
„ Gouriana, Roxb.
„ puberula, Hf. & T.
„ graveolens, Lindl.
„ orientalis. L.
„ nutans, Royle.
„ acuminata, DC.
„ connata, DC.
„ Buchananiana, DC.
Anemone vitifolia, Ham.
„ obtusiloba, Don.
„ rupestris, Wall.
„ rivularis, Ham.
„ polyanthes, Don.
„ narcissiflora, L.
„ tetrasepala, Royle.
„ elongata, Don.
Thalictrum elegans, Wall.
„ platycarpum, Hf. & T.
„ cultratum, Wall.
„ Chelidonii, Hf. & T.
„ reniforme, Wall.
„ pauciflorum, Royle.
„ rostellatum, Hf. & T.
„ Punduanum, Wall.
„ saniculæforme, DC.
„ Javanicum, Bl.
„ foliolosum, DC.
„ minus, L.
Callianthemum cachemirianum, Camb.
Adonis æstivalis, L.
Ranunculus aquatilis, L.
„ Lingua, L.
„ pulchellus, C. A. Mey.
„ lobatus, Jacquem.
„ hyperboreus, Rottb.
„ affinis, Br.
„ hirtellus, Royle.
„ sceleratus, L.
„ diffusus, DC.
„ lætus, Wall.
„ pensylvanicus, L.
„ arvensis, L.
Oxygraphis polypetala, Hf. & T.
Caltha palustris, L.
Trollius acaulis, Lindl.
Isopyrum thalictroides, L.
„ grandiflorum, Fisch.
Nigella sativa, L. *naturalised.*
Aquilegia vulgaris, L.
Delphinium denudatum, Wall.
„ cœruleum, Jacquem.
„ elatum, L.
„ vestitum, Wall.

Natural Order 1.—*Ranunculaceæ*—(concluded).

Delphinium Cashmirianum, Royle.
„ Ajacis, L., *introduced.*
Aconitum Lycoctonum, L.
„ palmatum, Don.
„ ferox, Wall.
„ Napellus, L.
„ heterophyllum, Wall.
Actæa spicata, L.
Cimicifuga fœtida, L.
Pæonia emodi, Wall.

Natural Order 2.—*Magnoliaceæ.*

Michelia Champaca, L., *introduced.*
Schizandra grandiflora, Hf. & T.
„ propinqua, Hf. & T.

Natural Order 3.—*Anonaceæ.*

Miliusa velutina, Hf. & T.

Natural Order 4.—*Menispermaceæ.*

Tinospora cordifolia, Miers.
Cocculus laurifolius, DC.
„ villosus, DC.
Stephania elegans, Hf. & T.
„ rotunda, Lour.
Cissampelos Pareira, L.

Natural Order 5.—*Berberideæ.*

Holboellia latifolia, Wall.
Berberis nepalensis, Spreng.
„ vulgaris, L.
„ aristata, DC.
„ Lycium, Royle.
„ asiatica, Roxb.
Podophyllum emodi, Wall.

Natural Order 6.—*Nymphæaceæ.*

Nelumbium speciosum, Willd., *introduced.*
Nymphæa Lotus, L.

Natural Order 7.—*Papaveraceæ.*

Papaver somniferum, L., *cultivated.*
„ dubium, L.
Argemone mexicana, L., *naturalized.*
Meconopsis aculeata, Royle.
„ robusta, Hf. & T.
„ nepalensis, DC.
Stylophorum lactucoides B. & Hf.

Natural Order 8.—Fumariaceæ.

Dicentra Roylei, Hf. & T.
" scandens, Walp.
Corydalis rutæfolia, Sibth.
" cachemiriana, Royle.
" crithmifolia, Royle.
" elegans, Wall.
" Govaniana, Wall.
" sibirica, Pers.
" cornuta, Royle.
" chærophylla, DC.
" meifolia, Wall.
" flabellata, Edgw.
Fumaria parviflora, Lamk.

Natural Order 9.—Cruciferæ.

Nasturtium officinale, Br.
" palustre, DC
" montanum, Wall.
Barbarea vulgaris, Br.
Arabis glabra, Crantz.
" alpina, L.
" amplexicaulis, Edgw.
Cardamine hirsuta, L.
" impatiens, L.
" macrophyla, Willd.
Allyssum canescens, DC.
Draba alpina, L.
" incana, L.
" lasiophylla, Royle.
" fladnitzensis, Wulf.
Sisymbrium mollissimum, C. A. Meyer.
" himalaicum, Hf. & T.
" Thalianum, Gay & Monn.
" rupestre, Edgw.
" strictum, Hf. & T.
" Wallichii, Hf. & T.
" Sophia, L.
" Columnæ, Jacq.
" Alliaria, Scop.
Eutrema primulæfolium, Hf. & T.
Erysimum hieraciifolium, L.
" altaicum, C. A. Meyer.
" Thomsoni, Hf.
Braya rosea, Bunge.
Brassica nigra, Koch.
" campestris, L.
" juncea, Hf. & T.
Fruca sativa, Lamk.
Capsella Bursa-pastoris, Mœnch.
Lepidium sativum, L.
" Draba, L.
" capitatum, Hf. & T.
Megacarnæa polyandra, Benth.
Thlaspi arvense, L.
" alpestre, L.
Iberidella Andersoni, Hf. & T.
Raphanus sativus, L., *cultivated.*
Goldbachia lævigata, DC.
Chorispora tenella, DC.

Natural Order 10.—Capparideæ.

Cleome viscosa, L.
Gynandropsis pentaphylla, DC.

Natural Order 10.—Capparideæ—(concld.)

Mærua arenaria, Hf. & T.
Capparis spinosa, L.
" horrida, L. f.
Cratæva religiosa, Forst.

Natural Order 11.—Violaceæ.

Viola biflora, L.
" Patrinii, DC.
" serpens, Wall,
" kunawarensis, Royle.
Ionidium suffruticosum, Ging.

Natural Order 12.—Bixineæ.

Cochlospermum Gossypium, DC.
Flacourtia Ramontchi, L'Herit.
" sepiaria, Roxb.
Xylosma longifolium, Clos.

Natural Order 13.—Pittosporeæ.

Pittosporum floribundum, W. & A.
" eriocarpum, Royle.

Natural Order 14.—Polygaleæ.

Polygala triphylla, Ham.
" crotalarioides, Ham.
" abyssinica, Fresen.
" leptalea, DC.
" persicariæfolia, DC.
" chinensis, L.
" sibirica, L.
Salomonia cantoniensis, Lour.

Natural Order 15.—Caryophylleæ.

Gypsophila cerastioides, Don.
Saponaria Vaccaria, L.
Silene inflata, Sm.
" conoidea, L.
" Falconeriana, Benth.
" Griffithii, Boiss.
" gallica, L.
" Moorcroftiana, Wall.
" Webbiana, Wall.
" Stracheyi, Edgw.
Cucubalus bacciferus, L.
Lychnis apetala, L.
" brachypetala, Hort. Berol.
" multicaulis, Wall.
" inflata, Wall.
" indica, Benth, *var.* fimbriata, Wall.
" nutans, Benth.
" pilosa, Edgw.
Cerastium dahuricum, Fisch.
" vulgatum, L.
" Thomsoni, Hf.
Stellaria crispata, Wall.
" paniculata, Edgw.
" semivestita, Edgw.

Natural Order 15.—Caryophylleæ—(concluded).

Stellaria aquatica, Scop.
„ media, L.
„ Webbiana, Wall.
„ latifolia, Benth.
„ longissima, Wall.
„ saxatilis, Ham.
„ glauca, With.
„ decumbens, Edgw.
Arenaria foliosa, Royle.
„ festucoides, Benth.
serpyllifolia, L.
„ orbiculata, Royle.
„ glanduligera, Edgw.
„ Stracheyi, Edgw.
„ holosteoides. Edgw.
„ Benthami, Edgw.
Sagina procumbens, L.
Spergula arvensis, L., in *fields.*
„ pentandra, L., *ditto.*
Drymaria cordata, Willd.
Polycarpæa corymbosa, Lamk.

Natural Order 16.—Portulaceæ.

Portulaca oleracea, L.

Natural Order 17.—Tamariscineæ.

Tamarix gallica, L.
„ dioica, Roxb.
Myricaria germanica, Desv.
„ elegans, Royle.

Natural Order 18.—Elatineæ.

Bergia ammannioides, Roxb.

Natural Order 19.—Hypericineæ.

Hypericum cernuum, Roxb.
„ cordifolium, Chois.
„ lysimachioides. Wall.
„ patulum, Thunb.
„ perforatum, L.
„ elodeoides, Chois.
„ nepaulense, Chois.

Natural Order 20.—Ternstrœmiaceæ.

Eurya japonica, Thunb.
Actinidia callosa, Lindl.
Saurauja nepaulensis, DC.
Camellia Thea, Link. Tea, *introduced and cultivated.*

Natural Order 21.—Dipterocarpeæ.

Shorea robusta, Gærtn., Sál.

Natural Order 22.—Malvaceæ.

Malva verticillata, L.
„ silvestris, L.
„ rotundifolia, L.
„ parviflora, L.
Sida rhombifolia, L.
„ cordifolia, L.
Abutilon polyandrum, Schl.
„ indicum. G. Don.
„ graveolens, W. & A.
Urena lobata, L.
„ repanda, Roxb.
Hibiscus Trionum. L.
„ furcatus, Roxb.
„ Solandra, L'Herit.
„ ficulneus, L.
„ pungens, Roxb.
„ Abelmoschus. L.
„ cancellatus, Roxb.
„ esculentus, L., *naturalized.*
Thespesia Lampas, Dalz. & Gibs.
Gossypium herbaceum, L., *introduced.*
Kydia calycina, Roxb.
Bombax malabaricum, DC.

Natural Order 23.—Sterculiaceæ.

Sterculia villosa, Roxb.
„ Roxburghii, Wall.
„ fulgens, Wall.
Helicteres Isora, L.
Pterospermum acerifolium, Willd., *rare.*
Melochia corchorifolia, L.
Waltheria americana, L.
Abroma augusta, L, *probably introduced.*

Natural Order 24.—Tiliaceæ.

Grewia oppositifolia, Roxb.
„ vestita, Wall.
„ tiliæfolia, Vahl.
„ asiatica, L.
„ sapida, Roxb.
„ scabrophylla, Roxb.
„ polygama, Roxb.
„ lævigata, Vahl.
Corchorus fascicularis. Lamk.
„ acutangulus, Lamk.
Triumfetta pilosa, Roth.
„ rhomboidea, Jacq.
„ annua, L.

Natural Order 25.—Lineæ.

Linum usitatissimum, L.
„ mysorense, Heyne.
Reinwardtia trigyna, Planch.

Natural Order 26.—Malpighiaceæ.

Hiptage Madablota, Gærtn.
Aspidopterys Wallichii, Hf.
„ nutans, Hf.

Natural Order 27.—Zygophyllaceæ.

Tribulus terrestris, L.

Natural Order 28.—Geraniaceæ.

Geranium palustre, L.
„ collinum, M. Bieb.
„ Wallichianum, Sweet.
„ nepalense, Sweet.
„ polyanthes, Edgw, & Hf.
„ rotundifolium, L.
„ molle, L.
„ Robertianum, L.
„ lucidum, L.
„ ocellatum, Camb.
Oxalis corniculata, L.
„ Acetosella, L.
Biophytum sensitivum, DC.
„ Reinwardtii, Walp.
Impatiens Roylei, Walp.
„ Thomsoni, Hf.
„ sulcata, Wall.
„ amplexicaulis, Edgw.
„ Balsamina, L., Mujethi.
„ scabrida, DC.
„ bicornuta, Wall.
„ amphorata, Edgw.

Natural Order 29.—Rutaceæ.

Boenninghausenia albiflora, Reichb.
Dictamus albus, L.
Xanthoxylon alatum, Roxb.
„ oxyphyllum, Edgw.
Toddalia aculeata, Pers.
Skimmia Laureola, Hf.
Glycosmis, pentapylla, Corr.
Limonia acidissima, L.
Murraya exótica, L.
„ Kœnigii, Spreng.
Clausena pentaphylla, DC.
Citrus medica, L.
„ Aurantium, L.
Ægle Marmelos, Corr.
Feronia Elephantum, Corr.

Natural Order 30.—Simarubeæ.

Ailanthus excelsa, Roxb.
Picrasma quassioides, Benn.

Natural Order 31.—Ochnaceæ.

Ochna pumila, Ham.

Natural Order 32.—Burseraceæ.

Boswellia serrata, Roxb.
Garuga pinnata, Roxb.

Natural Order 33.—Meliaceæ.

Melia Azedarách, L., Bukain.
„ composita, Willd.
Azadirachta Indica, Juss, Nim.
Cedrela serrata, Royle.
„ Toona, Roxb.

Natural Order 34.—Olacineæ.

Olax nana, Wall.

Natural Order 35.—Ilicineæ.

Ilex dipyrena, Wall.
„ excelsa, Wall.
„ odorata, Ham.

Natural Order 36.—Celastrineæ.

Euonymus pendulus, Wall,
„ echinatus, Wall.
„ grandiflorus, Wall.
„ Hamiltonianus, Wall.
„ lacerus, Ham.
„ tingens, Wall.
Celastrus paniculata, Willd., Malkagni.
Gymnosporia rufa, Wall
„ montana, Roxb.
„ Royleana, Wall.
Elæodendron glaucum, Pers.

Natural Order 37.—Rhamneæ.

Ventilago calyculata, Tulasne.
Zyzyphus Jujuba, Lamk.
„ Œnoplia, Mill.
„ vulgaris, Lamk.
„ xylopyra, Willd.
„ nummularia, W. & A.
„ oxyphylla, Edgw.
Berchemia floribunda, Wall.
Rhamnus purpureus, Edgw.
„ procumbens, Edgw.
„ virgatus, Roxb.
„ triqueter, Wall.
Sageretia oppositifolia Brongn.
„ theezans, Brongn.
Scutia indica, Brong.
Gouania leptostachya, DC.
„ nepalensis, Wall.
Hovenia dulcis, Thunb.

Natural Order 38.—Ampelideæ.

Vitis capreolata, Don.
„ latifollia, Roxb.
„ vinifera L., *introduced.*
„ Linnæi, Wall.
„ adnata, Wall.
„ lanata, Roxb.
„ himalayana, Brand.
„ parvifolia, Roxb.
„ obtecta, Wall.
„ divaricata, Wall.
Leea sambucina, Willd.
„ robusta, Roxb.
„ alata, Edgw.
„ aspera, Wall.

Natural Order 39.—Sapindaceæ.

Æsculus indica, Colebr.
Schleichera trijuga, Willd.
Sapindus trifoliatus, L.
„ Mukorossi, Gærtn., *probably introduced*

Natural Order 39.—*Sapindaceæ*—(concluded).

Sapindus Danura, Voigt., *probably introduced.*
Acer oblongum, Wall.
„ cæsium, Wall.
„ lævigatum, Wall.
„ pictum, Thunb.
„ villosum, Wall.
„ caudatum, Wall.
Melianthus major., L., *introduced.*
Staphylea Emodi, Wall.

Natural Order 40.—*Sabiaceæ.*

Sabia paniculata, Edgw.
„ campanulata, Wall.
Meliosma simplicifolia, Bl.
„ dilleniæfolia, Bl.

Natural Order 41.—*Anacardiaceæ.*

Rhus vernicifera, DC.
„ acuminata, DC.
„ semialata, DC.
„ Cotinus, L.
„ succedanea, L.
„ parviflora, Roxb.
Spondias Mangifera, Pers.
Mangifera indica, L.
Buchanania latifolia, Roxb.
Odina Wodier, Roxb.
Semecarpus Anacardium, L.

Natural Order 42.—*Coriarieæ.*

Coriaria nepalensis, Wall.

Natural Order 43.—*Moringeæ.*

Moringa pterygosperma, Gærtn.

Natural Order 44.—*Leguminosæ.*

Piptanthus nepalensis, Don.
Thermopsis barbata, Royle.
Crotalaria prostrata, Roxb.
„ alata, Roxb.
„ sericea, Retz.
„ juncea, L.
„ tetragona, Roxb.
„ albida, Heyne.
„ neglecta, W. & A.
Argyrolobium flaccidum, J. et S.
„ roseum, J. et S.
Parochetus communis, Ham.
Trigonella Fœnum-Græcum, L.
„ gracilis, Benth.
Medicago lupulina, L.
„ laciniata, All.
„ sativa, L., *cultivated.*
Melilotus parviflora, Desf.
„ alba, Lamk.
„ officinalis, L.

Natural Order 44.—*Leguminosæ*—(continued).

Trifolium repens, L.
„ pratense, L.
Lotus corniculatus, L.
Indigofera linifolia, Retz.
„ trifoliata, L.
„ trita, L.
„ tinctoria, L.
„ pulchella, Roxb.
„ Dosua, Ham.
„ atropurpurea, Ham.
„ hirsuta, L.
„ Gerardiana, Wall.
„ heterantha, Wall.
Tephrosia purpurea, Pers.
„ tenuis, Wall.
Millettia auriculata, Baker.
Caragana brevispina, Royle.
Colutea nepalensis, Sims.
Astragalus graveolens, Ham.
„ trichocarpus, Grah.
„ adesmiæfolius, Benth.
„ leucocephalus, Grah.
„ hosackioides, Benth.
„ rhizanthus, Royle.
„ Webbianus, Grah.
„ multiceps, Wall.
Oxytropis microphylla, DC.
Æschynomene indica, L.
Smithia sensitiva, Ait.
„ ciliata, Royle.
Zornia diphylla, Pers.
Ougeinia dalbergioides, Benth.
Desmodium oxyphyllum, DC.
„ gangeticum, DC.
„ laxiflorum, DC.
„ gyrans, DC.
„ podocarpum, DC.
„ tiliæfolium, Don.
„ floribundum, G. Don.
„ concinnum, DC.
„ polycarpum, DC.
„ parvifolium, DC.
„ triflorum, DC.
Uraria picta, Desv.
„ lagopus, DC.
„ lagopodoides, DC.
Alysicarpus vaginalis, DC.
„ bupleurifolius, DC.
Lespedeza elegans, Camb.
„ sericea, Miq.
„ eriocarpa, DC.
„ juncea, Pers.
Vicia sativa, L.
„ rigidula, Royle.
„ hirsuta, Koch.
„ tenera, Grah.
„ tenuifolia, Roth.
„ tetrasperma, Mœnch.
Lens esculenta, Mœnch, *cultivated.*
Lathyrus sativus, L.
„ luteus, Bak.
„ Aphaca, L.

Natural Order 44.—*Leguminosæ*—(concld.)

Pisum sativum, L., *introduced.*
Abrus precatorius, L.
Clitoria Ternatea. L.
Dumasia villosa, DC.
Shuteria involucrata, W. & A.
Glycine Soja, S. et Z.
Erythrina arborescens, Roxb.
,, resupinata, Roxb.
,, suberosa, Roxb.
Mucuna pruriens, DC.
,, atropurpurea, DC.
Butea frondosa, Roxb.
Spatholobus Roxburghii, Benth.
Pueraria tuberosa, DC.
Phaseolus Mungo, L.
,, aconitifolius, Jacq.
Vigna Catjang, End. } *cultivated.*
Dolichos Lablab, L.
Cajanus indicus, L.
Atylosia scarabæoides, Benth.
,, mollis, Benth.
Rhynchosia minima, DC.
,, Falconeri, Baker.
Flemingia semialata, Roxb.
,, strobilifera, R. Br.
,, vestita, Benth.
Dalbergia Sissoo. Roxb.
,, lanceolaria, L.
,, hircina, Benth.
,, volubilis, Roxb.
Pongamia glabra, Vent.
Sophora mollis, Wall.
Cæsalpinia Bonducella, Flemm.
,, sepiaria, Roxb.
Cassia Fistula, L.
,, Tora, L.
,, occidentalis, L.
,, Absus, L.
,, pumila, Lamk.
,, Wallichiana, DC.
Bauhinia racemosa, Lamk.
,, variegata, L.
,, retusa, Roxb.
,, Vahlii, W. & A.
,, purpurea, L.
Mimosa rubicaulis, Lamk.
,, pudica, L. Sensitive plant, *naturlized.*
Acacia Catechu, Willd.
,, pennata, Willd.
,, cæsia, W. and A.
,, Farnesiana. Willd, *naturalized.*
,, eburnea, Willd.
Albizzia lucida, Benth.
,, Lebbek, Benth.
,, odoratissima, Benth.
,, procera, Benth.
,, Julibrissin, Boiv.
,, stipulata, Boiv.

Natural Order 45.—*Rosaceæ.*

Prunus Puddum, Roxb.
,, Padus, L.

Natural Order 45.—*Rosaceæ*—(concld.)

Prunus domestica, L. Alucha, Plum, *introduced.*
,, armeniaca L., Zard Alu, Apricot, *cultivated.*
Amygdalus persica, L., Aru, Peach, *introduced.*
Prinsepia utilis, Royle.
Spiræa canescens, Don.
,, callosa, Thunb.
,, Kamtschatica, Pall.?
,, sorbifolia, L.
,, Aruncus, L.
Rubus acuminatus, Sm.
,, paniculatus, Sm.
,, parvifolius, L.
,, concolor, Wall.
,, niveus, Wall.
,, fruticosus, L.
,, flavus, Ham.
,, lasiocarpus, Sm.
,, rosæfolius, Sm.
,, biflorus, Ham.
,, asper, Don.
Geum elatum, Wall.
Fragaria indica, Andr.
,, vesca, L.
Agrimonia Eupatorium, Linn.
Potentilla fruticosa, L.
,, microphylla, Don.
,, multifolia, L.
,, Leschenaultiana, Sm.
,, fulgens, Wall.
,, nepalensis, Hook.
,, atrosanguinea, Lodd.
,, supina, L.
,, (Sibbaldia) procumbens, L.
Rosa Lyellii, Lindl.
,, moschata, Mill.
,, Brunonii, Lind.
,, macrophylla, Lind.
,, Webbiana, Wall.
,, sericea, Lind.
Pyrus Aria, Ehrh.
,, baccata, L., Gwála Mehal.
,, variolosa, Wall, Mehal.
,, communis. L., Nashpáti, Pear, *cultivated.*
,, Malus L., Seo, Apple, *cultivated.*
,, ursina, Wall.
,, foliolosa, Wall.
,, Cydonia, L., *introduced.*
Cratægus Pyracantha, Pers.
Cotoneaster acuminata, Lindl.
,, microphylla, Wall.
,, bacillaris, Wall.
,, nummularia, F. et M.

Natural Order 46.—*Saxifrageæ.*

Astilbe rivularis, Don.
Saxifraga ligulata, Wall.
,, Stracheyi, Hf. & T.
,, imbricata, Royle.

Natural Order 46.—Saxifrageæ—(concld.)

Saxifraga ramulosa, Wall.
,, granulata, L.
,, odontophylla, Willd.
,, micrantha, Edgw.
,, pallida, Wall.
,, flagellaris, Willd.
,, Brunonis, Wall.
,, filicaulis, Wall.
,, brachypoda, Don.
,, diversifolia, Wall.
,, Jacquemontiana, Dcne.
Chrysosplenium nepalense, Dcne.
Parnassia Wightiana, Wall.
,, nubicola, Wall.
Hydrangea altissima, Wall.
Deutzia corymbosa, R. Br.
,, staminea, R. Br.
Philadelphus coronarius, L.
Itea nutans, Royle.
Ribes Grossularia, L.
,, glaciale, Wall.
,, rubrum, L.
,, nigrum, L.

Natural Order 47.—Crassulaceæ.

Tillæa pentrandra, Royle.
Crassula indica, Dcne.
Bryophyllum, calycinum Salisb., *in gardens.*
Kalanchoe varians, Haw.
Cotyledon Oreades, Benth. et Hf.
Sodum crenulatum, Hf. & T.
,, quadrifidum, Pall.
,, Himalense, Don.
crassipes, Wall.
elongatum, Wall.
linearifolium, Royle.
pauciflorum, Edgw.
trifidum, Wall.
rosulatum, Edgw.
adenotrichum, Wall.
Ewersii, Ledeb.
multicaule, Wall.
,, Rhodiola, DC.

Natural Order 48.—Droseraceæ.

Drosera peltata *Var.* lunata, Ham.

Natural Order 49.—Haloragaceæ.

Myriophyllum spicatum, L.

Natural Order 50.—Combretaceæ.

Terminalia belerica, Roxb. Baharia.
,, Chebula, Retz. Har.
,, citrina, Roxb. Harira.
,, Arjuna, Bedd., Arjan.
,, tomentosa, Roxb. Saj.
Anogeissus latifolia, Wall.
Combretum decandrum, Roxb.

Natural Order 51.—Myrtaceæ.

Eugènia Jambolana, Lamk, Jáman.
,, caryophylli folia, Lamk.
Careya arborea, Roxb.
Barringtonia acutangula, Gærtn.

Natural Order 52.—Melastomaceæ.

Osbeckia stellata, Don.
,, angustifolia, Don.

Natural Order 53.—Lythracicæ.

Ammannia rotundifolia, Ham.
,, vesicatoria, Roxb.
Woodfordia floribunda, Salisb.
Lawsonia alba Lamk., Mehndi. *gardens.*
Lagerstrœmia parviflora, Roxb.
Punica Granatum, L., *wild and cultivated.*

Natural Order 54.—Onagracicæ.

Epilobium tomentosum, Boiss.
,, roseum, L.
Œnothera rosea, Sims., } *naturalized.*
,, sinuata L., }
,, grandiflora, }
Circæa Lutetiana, L.
,, alpina, L.

Natural Order 55.—Samydaceæ.

Casearia tomentosa, Roxb.

Natural Order 56.—Cucurbitaceæ.

Trichosanthes cucumerina, L.
,, palmata, Roxb.
Luffa cylindrica, Naud.
Cucumis Melo. L., *cultivated.*
,, sativus, L. ,,
,, Hardwickii, Royle.
Citrullus vulgaris, Schrd.
Bryonia laciniosa, L.
Mukia scabrelia, Arn.
Zehneria umbellata, Thw.

Natural Order 57.—Begoniaceæ.

Begonia picta, Wall.
,, amœna, Wall.

Natural Order 58.—Datiscaceæ.

Datisca cannabina, L.

Natural Order 59.—Ficoideæ.

Trianthema pentandra, L.
,, crystallina, Vahl.
Mollugo hirta, Thunb.
,, pentaphylla, L.
,, cerviana, Ser.

Natural Order 60.—Umbelliferæ.

Hydrocotyle asiatica, L.
Sanicula europæa, L.
Bupleurum tenue, Ham.
" longicaule, Wall.
" Candollei, Wall.
" falcatum, L.
" marginatum, Wall.
Apium graveolens, L., *introduced.*
Carum Copticum, Benth. et Hf. Ajwáin, *cultivated.*
Acronema tenerum, Edgw.
Pimpinella diversifolia, DC.
Chærophyllum villosum, Wall.
Œnanthe stolonifera, Wall.
Selinum Candollei, Bth. et Hf.
" Brunonis, DC.
" Govanianum, DC.
" angelicoide, DC.
Heracleum candicans, Wall.
" nepalense, Don.
Peucedanum graveolens, L. Sowa.
Coriandrum sativum, L., *cultivated.*
Daucus Carota, L., *cultivated.*
Torilis Anthriscus, Gmel.

Natural Order 61—Araliaceæ.

Aralia cachemirica, Dcne.
Heteropanax fragrans, Seem.
Hedera Helix, L.
Heptapleurum venulosum, Seem.

Natural Order 62—Cornaceæ.

Marlea begoniæfolia, Roxb.
Cornus macrophylla, Wall.
" oblonga, Wall.
" capitata, Wall.
Alangium Lamarckii, Thw.

Natural Order 63.—Caprifoliaceæ.

Abelia triflora, R. Br.
Leycesteria formosa, Wall.
Lonicera Myrtillus, Hf. & T.
" parvifolia, Edgw.
" purpurescens, Hf. & T.
" hypoleuca, Dcne.
" orientalis, Lamk.
" alpigena, L.
" heterophylla, Dcne.
" angustifolia, Wall.
" spinosa, Jacquem.
" quinquelocularis, Hardw.
Viburnum cotinifolium, Don.
" stellulatum, Wall.
" integerrimum, Wall,
" nervosum, Don.
" coriaceum, Bl.

Natural Order 64.—Rubiaceæ.

Adina cordifolia, Benth. et Hf.
Stephegyne parvifolia, Benth. et Hf.
Hymenodictyon excelsum, Wall.

Natural Order 64.—Rubiaceæ—(concld.)

Wendlandia exserta, DC.
" puberula, DC.
Argostemma sarmentosum, Wall.
" verticillatum, Wall.
Hedyotis Burmanniana, R. Br.
" aspera, Heyne.
" brachypoda, DC.
" gracilis, Wall.
Randia dumetorum, Lamk.
" tetrasperma, Roxb.
" uliginosa, DC.
Knoxia corymbosa, L.
Pavetta tomentosa, Sm.
Gardenia turgida, Roxb.
Coffera bengalensis, Roxb.
Hamiltonia suaveolens, Roxb.
Leptodermis lanceolata, Wall.
Spermacoce articularis, L.
Galium asperifolium, Wall.
" acutum, Edgw.
" rotundifolium, L.
" serpylloides, Royle.
" confertum, Royle.
" aparine, L.
Rubia cordifolia, L.
Asperula cynanchica, L.

Natural Order 65.—Valerianaceæ.

Valeriana Wallichii, DC.
" Hardwickii, Wall.

Natural Order 66—Dipsaceæ.

Morina longifolia, Wall.
" breviflora, Edgw.
Dipsacus inermis, Wall.

Natural Order 67.—Compositæ.

Vernonia anthelmintica, Willd.
" cinerea, Less.
Elephantopus scaber, L.
Adenostemma viscosum, Forst.
" var. elatum, Don.
" var. latifolium, Don.
Eupatorium longicaule, Wall.
" Wallichii, DC.
Solidago Virga-aurea, L.
Cyathocline lyrata, Cass.
Dichrocephala gracilis, DC.
Grangea madraspatana, Poir.
Myriactis nepalensis, Less.
" Wallichii, Less.
Aster alpinus, L.
" molliusculus, Benth.
" junceus, Benth.
" Thomsoni, C. B. Clarke.
(= Calimeris flexuosa, Royle.)
" peduncularis, Wall.
Erigeron acre, L.
" bellidioides, Benth.
Conyza veronicæfolia, Wall.

Natural Order 67.—*Compositæ* (contd.)

Conyza absinthifolia, DC.
,, viscidula, Wall.
Blumea lacera, DC.
,, runcinata, DC.
,, hieracifolia, DC.
Sphæranthus hirtus, Willd.
Leontopodium alpinum, Cass.
Anaphalis cinnamomea, Benth.
,, triplinervis, Sims.
,, nubigena, DC.
,, nubigena, *var.* polycephala, C. B. Clarke.
,, chionantha, DC.
,, araneosa, DC.
Gnaphalium multiceps, Wall.
,, indicum, L.
Cæsulia axillaris, Roxb.
Inula vestita, Wall.
,, nervosa, Wall.
,, barbata, Wall.
,, Cappa, DC.
Carpesium cernuum, L.
,, abrotanoides, L.
Siegesbeckia orientalis, L.
Eclipta erecta, L
Bidens tripartita, L.
Allardia tridactylites, Hf. & T.
Cotula anthemoides, L.
Tanacetum thibeticum, Hf. & T.
,, longifolium, Wall.
Artemisia vestita, Wall.
,, vulgaris, L.
Senecio densiflorus, Wall.
,, graciliflorus, DC.
,, laciniosus, Wall.
,, coronopifolius, Desf.
,, alatus, Wall.
,, rufinervis, DC.
,, Kunthianus, Wall.
,, Candolleanus, Wall.
Echinops niveus, Wall.
,, echinatus, Roxb.
Arctium Lappa, Willd.
Saussurea obvallata, Wall.
,, taraxacifolia, Wall.
,, Kunthiana, Wall.
,, depressa, Wall.
,, graminifolia, Wall.
,, Candolleana, Wall.
,, carthamoides, Benth.
,, albescens, Hf. & T.
,, candicans, DC.
,, Roylei, DC.
Jurinea macrocephala, Benth.
Serratula pallida, DC.
Tricholepis elongata, DC.
Leucomeris spectabilis, DC.
Ainsliæa pteropoda, DC.
,, aptera, DC.
Gerbera lanuginosa, Benth. et. Hf.
Berniera nepalensis, DC.
Tragopogon junceum, Wall.
Youngia lyrata, Cass.

Natural Order 67.—*Compositæ*—(concluded).

Lactuca graciliflora, Wall.
,, Brunoniana, Wall.
,, hastata, DC.
,, macrantha, Benth. et Hf.
,, longifolia, DC.
,, auriculata, DC.
,, sagittata, Hf. & T.
,, Tatarica, Benth.
Prenanthes hispidula, DC.
Taraxacum Dens-leonis, Desf.
Crepis fœtida, L.
Mulgedium Tataricum, DC.
Microrhynchus sarmentosus, DC.
Gynura nepalensis, DC.
Emilia sonchifolia, DC.
Doronicum Roylei, DC.

Natural Order 68.—*Campanulaceæ.*

Cyananthus integer, Wall.
,, linifolius, Wall.
Wahlenbergia agrestis, A DC.
Campanula latifolia, L.
,, sylvatica, Wall.
,, canescens, Wall.
,, colorata, Wall.
Lobelia trigona, Roxb.
,, pyramidalis, Wall.

Natural Order 69.—*Ericaceæ.*

Pernettya repens, Zoll.
Andromeda ovalifolia, Wall.
Rhododendron barbatum, Wall.
,, campanulatum, Don.
,, arboreum, Sm.
,, lepidotum, Wall.
,, anthopogon, Don.
Cassiope fastigiata, Don.

Natural Order 70.—*Primulaceæ.*

Primula floribunda, Wall.
,, petiolaris, Wall.
,, purpurea, Royle.
,, rosea, Royle.
,, minutissima, Wall.
,, involucrata, Wall.
,, sibirica, Jacq.
,, denticulata, Wall.
Andoosace sarmentosa, Wall.
,, Jacquemontii, Duby.
,, rotundifolia, Hardw.
,, incisa, Wall.
,, elegans, Duby.
Lysimachia lobelioides, Wall.
,, pyramidalis, Wall.
,, evalvis, Wall.
,, japonica, Thumb.
Anagallis arvensis, L.
Micropyxis pumila, Duby.
Samolus Valerandi, L.

Natural Order 71.—Myrsineæ.

Mæsa indica, A. DC.
,, argentea, Wall.
Embelia robusta, Roxb.
Myrsine semiserrata, Wall.
,, bifaria, Wall.
Ardisia humilis, Vahl.
,, floribunda, Wall.

Natural Order 72.—Sapotaceæ.

Bassia butyracea, Roxb.
,, latifolia, Roxb., *at low elevations : planted.*

Natural Order 73.—Ebenaceæ.

Diospyros exsculpta, Ham.
,, Melanoxylon, Roxb.
,, montana, Roxb.
,, Embryopteris, Pers.

Natural Order 74.—Styraceæ.

Symplocos cratægoides, Ham.
,, spicata, Roxb.
,, racemosa, Roxb.
,, ramosissima, Wall.

Natural Order 75.—Jasmineæ.

Jasminum laurifolium, Roxb.
,, pubescens, Willd.
,, punctatum. Wall.
,, arborescens. Roxb.
,, latifolium, Roxb.
,, dispermum. Wall.
,, revolutum. Sims
,, pubigerum. Don.
,, officinale. L.
,, grandiflorum, L.
,, Zambac, Ait., *cultivated.*
Nyctanthes Arbor-tristis, L.

Natural Order 76.—Oleaceæ.

Fraxinus floribunda. Wall.
Ligustrum nepalense. Wall.
,, compactum. Hf. & T.
Olea cuspidata. Wall.
,, glandulifera, Wall.
Chionanthus macrophylla. Wall.
Syringa emodi, Wall.

Natural Order 77.—Apocyneæ.

Carissa diffusa, Roxb.
Ophioxylon serpentinum. Willd.
Tabernæmontana coronaria, R. Br.
Vinca pusilla, Murr.
Vallaris dichotoma, Wall.

Natural Order 77.—Apocyneæ—(concld).

Wrightia mollissima, Wall.
Holarrhena antidysenterica, Wall.
Alstonia scholaris, R. Br.
Nerium odorum, Solander.
Chonemorpha macrophylla, G. Don.
Ichnocarpus fragrans, Wall.
,, frutescens, R. Br.

Natural Order 78.—Asclepiadaceæ.

Cryptolepis elegans, Wall.
Vincetoxicum canescens, Dcne.
,, montanum, Dcne.
Calotropis procera, R. Br.
Dæmia extensa, R. Br.
Periploca calophylla, Falc.
Tylophora carnosa, Wall.
Marsdenia Roylei, Wight.
Pergularia odoratissima, L.
Orthanthera viminea, Wight.
Hoya parasitica, Wall.
Ceropegia longifolia, Wall.
,, lanceolata, Wight.

Natural Order 79.—Loganiaceæ.

Gardneria angustifolia, Wall.
Buddleia paniculata. Wall.
,, asiatica. Lour.

Natural Order 80.—Gentianaceæ.

Exacum tetragonum, Roxb.
,, pedunculatum. L.
Canscora decussata. R. et S.
,, diffusa. R. Br.
Gentiana tenella, Fries.
,, pedicellata. Wall.
,, argentea, Royle.
,, capitata. Ham.
,, decemfida, Ham.
,, marginata. Griseb.
,, venusta. Wall.
,, depressa. Don.
,, Kurroo, Royle.
Crawfurdia fasciculata, Wall.
Ophelia cordata, Don.
,, lurida. Don.
,, purpurascens. Don.
,, nervosa. Wall.
,, pulchella. Don.
,, angustifolia, Don.
,, Chirayta. Griseb.
Halenia elliptica. Don.
Swertia speciosa. Wall.

Natural Order 81.—Bignoniaceæ.

Calosanthes indica. Bl.
Stereospermum chelonoides, DC.
,, suaveolens, DC.

Natural Order 82.—Pedaliaceæ.

Martynia proboscidia. Glox. *naturalized.*
Sesamum indicum, L., Tili, *cultivated.*

Natural Order 83.—Convolvulaceæ.

Argyreia speciosa, Sweet.
„ capitata, Choisy.
„ setosa, Choisy.
Quamoclit coccinea, Mœnch, } *escaped from gardens.*
„ vulgaris, Choisy, }
Patatas pentaphylla, Choisy.
Pharbitis Nil, Choisy.
Calonyction speciosum, Choisy.
Ipomœa Pes-tigridis, L.
„ Turpethum, R. Br.
„ vitifolia, Sweet.
„ pilosa, Sweet.
„ sessiliflora, Choisy.
Convolvulus pluricaulis, Vahl.
Porana paniculata, Roxb.
„ racemosa, Roxb.
Evolvulus alsinoides, L.
Cuscuta reflexa, Roxb.

Natural Order 84.—Boraginaceæ.

Gynaion vestitum, A. DC.
Cordia Rothii, R. et S.
„ Myxa, L.
„ latifolia. Roxb.
Ehretia lævis, Roxb.
„ serrata, Roxb.
Rhabdia viminea, Dalz.
Heliotropium ovalifolium, Vahl.
„ strigosum, Willd.
Macrotomia Benthami, DC.
Mertensia echioides, Hf. and T.
Myosotis cæspitosa, Schult.
„ rotundifolia, R. Br.
Eritrichium rotundifolium, DC.
„ sericeum, Royle.
„ spathulatum Royle.
Echinospermum glochidiatum, DC.
Cynoglossum furcatum, Wall.
„ micranthum, DC.
„ longiflorum, Benth.
„ grandiflorum, Royle.
Trichodesma indicum, R. Br.

Natural Order 85.—Solanaceæ.

Solanum tuberosum, L., Potato, *introduced.*
Solanum nigrum, L.
„ verbascifolium, L.
„ sanctum, L.
„ xanthocarpum, Schr.
„ indicum, L.
Physalis minima, L.

Natural Order 85.—Solanaceæ.—(concld.)

Physalis Peruviana, L., *introduced and almost naturalized.*
Capsicum frutescens, L., Lál-mirch, Chilli, *introduced and naturalized.*
Nicandra physaloides, Gærtn, *naturalized.*
Withania somnifera, Don.
Nicotiana Tabacum, L.. Tamáku, *introduced and naturalised.*
Datura Stramonium, L.
„ fastuosa, L.

Natural Order 86.—Scrophulariaceæ.

Verbascum Thapsus, L.
Celsia coromandeliana, L.
Linaria ramosissima, Wall.
Antirrhinum Orontium, L.
Mimulus nepalensis, Wall.
„ gracilis R. Br.
Mazus surculosus, Don.
„ rugosus, Lour.
Lindenbergia grandiflora, Benth.
„ urticæfolia, Lehm.
„ macrostachya, Benth.
Limnophila gratioloides, R. Br.
Herpestis Hamiltoniana, Benth.
„ Monnieria, H. B. K.
Torenia cordifolia, Roxb.
Vandellia crustacea, Benth.
Bonnaya brachiata, Link.
„ veronicæfolia, Spr.
Hemiphragma heterophyllum, Wall.
Scoparia dulcis, L., *naturalised.*
Veronica Anagallis, L.
„ Beccabunga, L.
„ deltigera, Wall.
„ lanosa, Benth.
„ alpina, L.
„ biloba, L.
„ agrestis, L.
Buchnera hispida, Lamk.
Striga euphrasioides, Benth.
„ densiflora, Benth.
„ hirsuta, Benth.
Leptorhabdos parviflora, Benth.
Sopubia trifida, Don.
Euphrasia officinalis, L.
Picrorhiza Kurrooa, Royle.
Pedicularis tubiflora, Fisch.
„ carnosa, Wall.
„ pectinata, Wall.
„ pyramidata, Royle.
„ gracilis, wall.
„ porrecta, Wall.
„ abrotanifolia, Bieb.
„ megalantha, Don.

Natural Order 87.—Lentibularieæ.

Utricularia flexuosa, Vahl.

Natural Order 88.—*Orobancheæ.*

Phelipæa indica, G. Don.
Æginetia indica, Roxb.

Natural Order 89.—*Gesneraceæ.*

Didymocarpus subalternans, Wall.
„ aromaticus, Wall.
„ macrophyllus, Wall.
„ pedicellatus, R. Br.
„ lanuginosus, Wall
Chirita bifolia, Don.
Rhynchoglossum obliquum. Bl.
Platystemma violoides, Wall.
Lysionotus ternifolius, Wall.

Natural Order 90—*Acanthaceæ.*

Thunbergia grandiflora. Roxb.
„ coccinea, Wall.
Ebermaiera glauca. N. ab. E.
Hygrophila polysperma. T. Anders.
„ spinosa, T. Anders.
Petalidium barlerioides, N. ab E.
Hemigraphis Pavala, T. Anders.
Strobilanthes auriculatus, N. ab E.
„ glutinosus, T. Anders.
„ alatus, N. ab E.
„ Wallichii, N. ab E.
„ isophyllus. T. Anders.
„ anisophyllus. T. Anders.
Æchmanthera Wallichii, N. ab E.
Daedalacanthus nervosus, T. Anders.
Barleria cristata. L.
Lepidagathis cuspidata. N. ab E.
„ purpuricaulis. N. ab E.
„ hyalina. N. ab E.
„ fasciculata, N. ab E.
Phlogacanthus thyrsiflorus, N. ab E.
Justicia Adhatoda, L.
„ peploides. T. Anders.
„ procumbens, L.
Rungia pectinata, N. ab E.
„ repens, N. ab E.
Dicliptera Roxburghiana, N. ab E.
Peristrophe bicalyculata, N. ab E.
„ speciosa, N. ab E.

Natural Order 91.—*Verbenaceæ.*

Verbena officinalis, L.
Lippia nodiflora, Rich.
Lantana alba, Mill.
Premna viburnoides, Wall.
„ mucronata, Roxb.
„ barbata, Wall.
„ herbacea, Roxb.
Callicarpa arborea, Roxb.
„ macrophylla, Vahl.
Clerodendron serratum, Spr.
„ infortunatum, L.
„ Siphonanthus, R. Br.

Natural Order 91.—*Verbenaceæ.* —(concluded).

Caryopteris Wallichiana, Schauer.
Gmelina arborea, Roxb.
Vitex Negundo, L.
Holmskioldia sanguinea, Retz.

Natural Order 92.—*Labiatæ.*

Ocimum canum, L.
„ sanctum. L, *naturalized.*
Orthosiphon rubicundus, Benth
Plectranthus scrophularioides, Wall.
„ striatus, Benth.
„ Coetsa, Don.
„ ternifolius. Don.
„ cordifolius, Don.
Coleus barbatus, Benth.
Pogostemon plectranthoides, Desf.
Dysophylla cruciata, Benth.
„ pumila, Benth.
Colebrookia oppositifolia, Sm.
Elsholtzia polystachya, Benth.
„ flava, Benth.
„ incisa, Benth.
„ eriostachya, Benth.
„ strobilifera. Benth.
Mentha arvensis, L.
„ incana. Willd, *var.* Royleana, Benth.
Origanum normale, Don.
Melissa calamintha, L.
Micromeria biflora, Benth.
Hedeoma nepalensis, Benth.
Salvia glutinosa, L.
„ Moorcroftiana, Wall.
„ lanata. Roxb.
„ plebeja. R. Br.
Nepeta spicata, Benth.
„ distans, Royle.
„ ciliaris. Royle.
„ ruderalis, Ham.
„ leucophylla, Benth.
„ Govaniana, Benth.
Lallemantia Royleana, Benth.
Anisomeles ovata, R. Br.
Prunella vulgaris, L.
Scutellaria grossa, Benth.
„ repens. Ham.
„ linearis. Benth.
„ scandens, Don.
Caryotome versicolor, Benth.
Leonurus Royleanus, Benth.
„ pubescens, Benth.
„ cardiacus, L.
Lamium amplexicaule, L.
„ petiolatum, Royle.
Colquhounia coccinea, Wall.
Stachys sericea. Wall.
„ splendens, Wall.
Roylea elegans, Wall.
Leucas urticæfolia, R. Br.
„ lanata, Benth.
„ mollissima, Wall.

Natural Order 92.—Labiatæ —(concluded).

Leucas diffusa, Benth.
„ hyssopifolia, Benth.
„ cephalotes. Spr.
Leonotis nepetæfolia, R. Br.
Phlomis lamiifolia. Royle.
Eremostachys superba. Royle.
Ajuga remota. Benth.
„ bracteosa, Wall.
Teucrium Royleanum, Benth.
„ quadrifarium. Ham.

Natural Order 93.—Plantagineæ.

Plantago major. L.
„ Ispaghula, Roxb.

Natural Order 94.—Chenopodiaceæ.

Chenopodium album, L.
„ Botrys, L.

Natural Order 95.—Basellaceæ.

Basella rubra, L. *cultivated and naturalized.*

Natural Order 96.—Amarantaceæ.

Deeringia celosioides, Moq.
Rodetia Amherstiana, Moq.
Celosia argentea, Moq.
Amaranthus caudatus, L. *cultivated and naturalized.*
Amaranthus paniculatus; Moq.
„ Gangeticus, L.
„ frumentaceus, Roxb. Rámdana, Anárdana. *cultivated and naturalized.*
„ spinosus. L.
Ærua scandens, Wall.
„ lanata, Juss.
Achyranthes aspera. L.
Digera arvensis, Forsk.
Pupalia lappacea. DC.
Cyathula prostrata. Bl.
Alternanthera sessilis. R. Br.

Natural Order 97.—Nyctagineæ.

Boerhaavia diffusa, L.
Mirabilis Jalapa, L., *introduced and naturalized.*

Natural Order 98.—Phytolacceaceæ.

Pircunia Latbenia, Moq.

Natural Order 99.—Polygonaceæ.

Rumex Wallichii, Meissn.
„ nepalensis. Spr.
„ hastatus, Don.

Natural Order 99.—Polygonaceæ. —(concluded).

Rumex vesicarius, L.
Kœnigia Islandica, L.
Rheum emodi, Wall.
„ himalense, Royle.
Polygonum Roxburghii, Meissn.
„ plebeium, R. Br.
„ herniarioides, Del.
„ recumbens, Royle.
„ aviculare, L.
„ barbatum, L.
„ amphibium, L.
„ lapathifolium, L.
„ sphærostachyum, Meissn.
„ amplexicaule, Don.
„ vacciniæfolium, Wall.
„ affine, Don.
„ nepalense, Meissn.
„ sphærocephalum, Don.
„ capitatum, Ham.
„ chinense, L.
„ pteropcarpum, Wall.
„ rumicifolium. Royle
Fagopyrum esculentum, Mœnch.
„ cymosum, Meissn.
„ tataricum. Gærtn.

Natural Order 100.—Laurineæ.

Cinnamomum Tamala, N. ab E., var. albiflorum. Tejpát.
Phœbe lanceolata, N. ab E.
„ pallida. N. ab E.
Machilus odoratissimus, N. ab E.
Tetranthera Roxburghii. N. ab E.
„ monopetala, Roxb.
Litsæa consimilis. N. ab E.
„ lanuginosa, N. ab E.

Natural Order 101.—Thymelaceæ.

Daphne papyracea, Wall.
Wikstrœmia virgata, Meissn.

Natural Order 102.—Loranthaceæ.

Loranthus ligustrinus, Wall.
„ pulverulentus, Wall.
„ vestitus. Wall.
„ longiflorus. Desv.
„ cordifolius, Wall.
Viscum album. L.
„ articulatum, Burm.
„ attenuatum, D.C.

Natural Order 103.—Elæagneæ.

Hippophaë salicifolia, Don.
Elæagnus umbellata. Thunb.
„ latifolia, L.

Natural Order 104.—Santalaceæ.

Osyris arborea, Wall.

Natural Order 105.—*Aristolochiaceæ.*

Aristolochia bracteata, Retz.

Natural Order 106.—*Euphorbiaceæ.*

Phyllanthus nepalensis, Müll.
,, parvifolius. Wall.
,, velutinus, Müll.
,, Miruri, L.
,, Emblica, L.
Antidesma diandrum, Tlue.
Securinega obovata, Müll.
,, Leucopyrus, Müll.
Putranjiva Roxburghii, Wall.
Andrachne cordifolia, Müll.
Bischoffia javanica, Bl.
Briedelia montana, Willd.
,, stipularia, Bl.
Croton oblongifolius, Roxb., *introduced.*
Trewia nudiflora, Willd.
Mallotus philippinensis, Müll, (Rottlera tinctoria, Roxb.).
Ricinus communis, L., *cultivated.*
Homonoya riparia, Lour.
Baliospermum polyandrum, Wight.
Excœcaria insignis, Müll.
Euphorbia indica. Lamk.
,, pilulifera, L.
,, neriifolia, L.
,, Sikkimensis, Boiss.
,, longifolia. Don.
,, Helioscopia, L.
,, nepalensis. Boiss.
,, Nivulia, Ham.
,, Royleana, Boiss.
Sarcococca pruniformis, Lindl.

Natural Order 107.—*Cupuliferæ.*

Quercus semecarpifolia, Sm.
,, Ilex, L.
,, dilatata, Lindl.
,, lanuginosa, Don.
,, incana, Roxb.
,, annulata, Sm.

Natural Order 108.—*Myricaceæ.*

Myrica sapida, Wall.

Natural Order 109.—*Betulaceæ.*

Betula Bhojpattra, Wall.
,, acuminata, Wall.
,, nitida, Don.
Alnus nepalensis, Don.

Natural Order 110.—*Corylaceæ.*

Carpinus viminea, Wall.
,, faginea, Lindl.
Corylus Colurna, Linn.

Natural Order 111.—*Juglandeæ.*

Juglans regia, L.
Engelhardtia Colebrookiana, Lindl.

Natural Order 112.—*Salicineæ.*

Salix tetrasperma, Roxb.
,, babylonica, L., *introduced.*
,, elegans, Wall.
,, daphnoides, L.
,, flabellaris, Anders.
,, Lindleyana, Wall.
Populus ciliata, Wall.

Natural Order 113.—*Urticaceæ.*

Ulmus integrifolia, Roxb.
,, erosa, Roth.
Celtis caucasica, Willd.
,, australis, L.
Sponia politoria, Planch.
,, orientalis, Planch.
Cannabis sativa, L.
Urtica parviflora, Roxb.
Girardinia heterophylla, Dcne.
Pilea scripta, Wedd.
Lecanthus peduncularis, Wedd.
Elatostemma sessile, Forst.
,, diversifolium, Wedd.
,, Stracheyanum, Wedd.
Bœhmeria rugulosa, Wedd.
,, macrophylla, Don.
,, platyphylla, Don.
Pouzolzia indica, Gaud.
,, viminea, Wedd.
Debregeasia longifolia, Wedd.
,, bicolor, Wedd.
Memorialis pentandra, Wedd.
,, hirta, Wedd.
Villebrunea frutescens, Bl.
Maoutia Puya, Wedd.
Cudrania javanensis, Trec.
Streblus asper, Lour.
Morus atropurpurea, Roxb., *introduced.*
,, lævigata, Wall.
,, indica, L.
,, alba, Willd, *cultivated.*
Ficus bengalensis, L., Bar.
,, infectoria, Willd.
,, religiosa, L., Pipal.
,, cordifolia, Roxb.
,, nemoralis, Wall.
,, caudata, Wall.
,, scandens, Roxb.
,, foveolata, Wall.
,, tuberculata, Wall.
,, Roxburghii, Wall.

Natural Order 113.—*Urticaceæ.* —(concluded).

Ficus hispida, L. f.
„ Cunia, Ham.
„ glomerata, Willd., Gular.
„ Carica, L. *introduced.*
„ virgata, Roxb.

Natural Order 114.—*Piperaceæ.*

Peperomia reflexa, Dietr.

Natural Order 115.—*Gnetaceæ.*

Ephedra vulgaris, Rich.

Natural Order 116.—*Coniferæ.*

Pinus longifolia, Roxb.
„ Gerardiana, Wall.
„ excelsa, Wall.
Abies Webbiana, Lindl.
„ Smithiana, Forbes.
Cedrus Deodara, Loud.
Cupressus torulosa, Don.
Juniperus communis, L.
„ excelsa, Bieb.
„ recurva, Ham.
Taxus baccata, L.

Natural Order 117.—*Palmaceæ.*

Phœnix acaulis, Roxb.
„ sylvestris, Roxb.
Chamærops Martiana, Wall.
Calamus Royleanus, Griff.
Wallichia densiflora, Mart.

Natural Order 118.—*Aroideæ.*

Arisæma Jacquemontii, Bl.
„ utile, Hf. & T.
„ costatum, Mart.
„ speciosum, Mart.
„ curvatum, Kunth.
Sauromatum guttatum, Schott.
Remusatia vivipara, Schott.
Amorphophallus campanulatus, Bl.
Colocasia, species.
Scindapsus officinalis, Schott.
„ *decursiva, Schott.
Typhonium, species.
Pothos scandens, L.
Acorus calamus, L.

Natural Order 119.—*Lemanacea*

Lemna minor, L.
„ polyrrhiza, L.

Natural Order 120.—*Typaceæ.*

Typha elephantina, Roxb.

Natural Order 121.—*Juncaginaceæ.*

Potamogeton pectinatus, L.
Aponogeton monostachyus, Roxb.

Natural Order 122.—*Scitamineæ.*

Globba Orixensis, Roxb.
Zingiber capitatum, Roxb.
„ Casumunar, Roxb.
„ ligulatum, Roxb.
Curcuma angustifolia, Roxb.
„ Zerumbet, Roxb.
Roscoea elata, Sm.
„ alpina, Roxb.
„ spicata, Sm.
„ purpurea, Sm.
Amomum subulatum, Roxb.
Hedychium coronarium, L., *in gardens.*
„ spicatum, Sm.
„ coccineum, Ham.
Costus speciosus, L.
Musa paradisiaca, L. plantain, *cultivated.*
„ nepalensis, Wall.

Natural Order 123—*Orchidaceæ.*

Oberonia iridifolia, Lindl.
Dienia cylindrostachya, L.
Liparis obcordata, Vahl.
Cœlogyne cristata, Lindl.
„ ocellata, Lindl.
„ ovalis, Lindl.
Eria convallarioides, Lindl.
„ alba, Lindl.
„ flava, Lindl.
Dendrobium eriæflorum, Griff.
„ alpestre, Royle.
Otochilus, species.
Apaturia Smithiana, Lindl.
Eulophia, campestris, L.
„ herbacea, Lindl.
Cyrtopera fusca, Wight.
Vanda cristata, Lindl.
Saccolabium guttatum, Lindl.
„ Gharwalicum, Reichb. f.
Aerides affine, Wall.
„ odoratum, Lowe.
„ Hystrix, Lindl.
„ difforme, Wall.
Calanthe puberula, Lindl.
Orchis latifolia, L.
Gymnadenia cucullata, Rich.
„ spathulata, Lindl.
Aceras angustifolia, Lindl.
Platanthera orchidis, Lindl.
„ clavigera, Lindl.
„ obcordata, Lindl.
„ Susannæ, Lindl.
„ candida. Lindl
„ acuminata, Lindl.

Natural Order 123.—*Orchidaceæ* —(concluded).

Gamoplexis orobanchoides, Falc.
Epipactis latifolia, Sw.
„ macrostachys, Lindl.
Spiranthes australis, R. Br.
Habenaria pectinata, Lindl.
„ intermedia, Don.
„ marginata, Lindl.
„ longifolia, Lindl.
Peristylus Goodyeroides Lindl.
Herminium Monorchis, Sw.
„ species.
Satyrium nepalense, Don.
Monochilus flavus, Wall.
Tripleura pallida, Lindl.
Goodyera marginata, Lindl.
Cypripedium cordigerum, Don.

Natural Order 124.—*Iridaceæ.*

Iris sulcata, Wall.
„ decora, Wall.
„ Ramaonensis, Wall.
„ nepalensis, Wall.

Natural Order 125.—*Amaryllidaceæ.*

Crinum toxicarium, Roxb.
„ amœnum, Roxb.
Curculigo recurvata, Roxb.
Hypoxis aurea, Lour.
„ orchioides, Kz.

Natural Order 126.—*Dioscoreæ.*

Dioscorea deltoidea, Wall.
„ sagittata, Royle.
„ pentaphylla, L.

Natural Order 127.—*Liliaceæ.*

Tulipa stelleta, Hook.
Gagea thesioides, Fisch.
„ elegans, Wall.
Iphigenia indica, Kth.
Lloydia serotina, Reichb.
Fritillaria cirrhosa, Don.
„ verticillata, Boyle.
Lilium giganteum, Wall.
Wallichianum, R. et. S.
nepalense, Wall.
Thomsonianum, Hf.
roseum, L.
Gloriosa superba, L.
Allium Victoriale, L.
Wallichii, Kth.
tuberosum, Roxb.
Govanianum, Wall.
consanguineum, Kth.
rubens, Schrad.

Natural Order 127.—*Liliaceæ.*—(concld.)

Urginea indica, Kunth.
Asphodelus clavatus, Roxb.
Asparagus racemosus, Willd.
„ filicinus, Ham.
Polygonatum multiflorum, All
„ sibiricum, Red.
„ verticillatum, All.
Flüggea intermedia, Sch.
„ Wallichiana, Kth.
Smilax maculata, Roxb.
„ elegans, Wall.
„ macrophylla, Roxb.
„ ovalifolia, Roxb.
Paris polyphylla, Sm.
Trillidium Govanianum, Kth.
Disporum Pitsutum, Don.
„ calcaratum, Don.

Natural Order 128.—*Alismaceæ.*

Alisma Plantago, L.
„ reniforme, Don.
Sagittaria sagittifolia, L.

Natural Order 129.—*Pontederaceæ.*

Monochoria hastata, Presl.

Natural Order 130.—*Commelynaceæ.*

Cyanotis axillaris, R. et S.
„ barbata Don.
Commelyna salicifolia, Roxb.
„ bengalensis. L.
„ obliqua, Ham.
Aneilema herbaceum, Wall.

Natural Order 131.—*Juncaceæ.*

Juncus concinnus, Don.
„ leucomelos, Royle.
„ castaneus, L.
„ bufonius, L.
„ effusus, L.
„ leucanthus, Don.

Natural Order 132.—*Restiaceæ.*

Eriocaulon quinquangulare, L.
„ trilobum, Ham.
„ sexangulare, L.

Natural Order 133.—*Cyperaceæ.*

Carex rigida, Good.
„ Thomsoni, Boot.
„ mitis, Boot.
„ nubigena, Don.
„ foliosa, Don.

Natural Order 133.—*Cyperaceæ*— (concluded.)

Carex longipes, Don.
,, Moorcroftii, Falc.
,, alopecurioides, Don.
,, Wallichiana, Presc.
,, setigera, Don.
,, cruenta, Nees.
,, uncinoides, Boot.
,, vesiculosa, Boot.
,, filicina, Nees.
,, condensata, Nees.
,, bengalensis, Roxb.
Rhynchospora aurea, Nees.
,, Wallichiana, Nees.
Fimbristylis quinquangularis, Nees.
,, dichotoma, Vahl.
,, æstivalis, Vahl.
,, complanata, Link.
Scirpus juncoides, Roxb.
,, affinis, Roth.
,, mucronatus, L.
Abilgaárdia monostachya, Vahl.
Eleocharis uniglumis, R. Br.
,, palustris, R. Br.
,, ovata, R. Br.
Isolepis setacea, R. Br.
,, trifida, Nees.
,, supina, R. Br.
,, Roylei, Nees.
Kyllingia monocephala, L.
,, brevifolia, Rottb.
,, triceps, Nees.
Eriophorum comosum, Wall.
Cyperus pygmæus, Vahl.
,, alopecuroides, Rottb.
,, compressus, L.
,, niveus, Retz.
,, difformis, L.
,, Iria, L.
,, rotundus, L.
Mariscus paniceus, Vahl.

Natural Order 134.—*Gramineæ.*

Oryza sativa, L., Rice, *cultivated.*
Zea Mays, L., Makai, Bhuta, Indian Corn, *introduced and cultivated.*
Coix Lachryma, L.
,, gigantea, Koen.
Milium effusum, L., *introduced.*
Paspalum pedicellatum, Nees.
,, scrobiculatum, L. *cultivated.*
,, Royleanum, Nees.
Coridochloa semialata, Nees.
Panicum sanguinale, L.
,, ciliare, Retz.
,, miliaceum, L., *cultivated.*
,, maximum, Jacq.
,, ovalifolium, Poir.
,, longipes, W. & A.
,, miliare, Lamk.
,, vestitum, Nees.
,, plicatum, Roxb.

Natural Order 134.—*Gramineæ* (contd.)

Panicum prostratum, Lamk.
,, repens, L.
Oplismenus colonus, Kth.
,, compositus, R. & S.
,, frumentaceus, Kunth, *cultivated.*
,, stagninus, Kth.
Setaria glauca, Beauv.
,, italica, Kth., *naturalized; cultivated.*
,, verticillata, Beauv.
Penicillaria spicata, Lamk, Bajra, *cultivated.*
Pennisetum cenchroides, Rich.
,, triflorum, Nees.
Gymnothrix flaccida, Munro.
Arundinella setosa, Trin.
Sporobolus diandra, Beauv.
,, elongatus, R. Br.
Agrostis alba, L
,, ciliata, Trin.
Mühlenbergia sylvatica, Trin.
,, geniculata, Nees.
,, viridissima, Nees.
Polypogon littoralis, L.
Calamagrostis Epigejos, Roth.
Orthoraphium Roylei, Nees.
Piptatherum æquiglume, Munro.
Alopecurus pratesis, L.
Phleum arenarium, L.
Phragmites Roxburghii, Kunth.
Chloris barbata, Swartz.
Eleusine indica Gærtn
,, Coracana, Gærtn, *cultivated.*
,, verticillata, Roxb.
Cynodon Dactylon, Pers, Dub.
Avena fatua, L.
,, pratensis, L.
Poa annua, L.
,, pratensis, L.
,, bulbosa, L.
Eragrostis plumosa, Link.
,, pilosa, L.
,, verticillata, Beauv.
,, unioloides, Nees.
,, poæoides, Beauv.
,, nardoides Trin.
,, diandra, Roxb.
Melica ciliata, L.
Kœleria cristata, Pers.
,, phleoides, Pers.
Dactylis glomerata. L.
Festuca duriuscula, L.
Bromus squarrosus, L.
,, arvensis, L.
,, giganteus, L.
Arundinaria falcata, Nees.
,, Falconeri, Kz.
Thamnocalamus spathiflorus, Munro,
Bambusa arundinacea, L.
Dendrocalamus strictus, Nees.
Hordeum hexastichon L., Jau, Barley, *cultivated.*

Natural Order 134.—*Gramineæ*—(concld.)

Hordeum vulgare, L., *cultivated.*
Elymus sibiricus, L.
Lolium speciosum, Stev.
" temulentum, L.
Triticum vulgare, Vil., Gehún, Wheat, *cultivated.*
Mnesithea lævis, Kth.
Rottbœllia exaltata, L.
Ophiurus corymbosus, Grtn.
Manisurus granularis, Sw.
Andropogon Gryllus, L.
" acicularis, Retz.
" involutus, Steud.
" montanus, Roxb.
" Ischæmum, L.
Heteropogon contortus, R. & S.
" Roylei, Nees
Sorghum vulgare, Pers., Joar, *cultivated.*
" Halepense, L.
Apocopis Royleanus, Nees
Batratherum molle. Nees.
" lancifolium, Trin.
" echinatum, Nees.
Anatherum muricatum, Beauv.
Cymbopogon laniger, Desf.
" flexuosus, Nees
" Martini, Munro.
" Schœnanthus, L.
" Nardus, L.
Androscepia gigantea, Brongn.
Anthistiria arundinacea, Nees.
" Anathera, Nees.
" scandens, Roxb.
Apluda aristata, L.
" geniculata, Roxb.
Imperata arundinacea, Cyrill.
Saccharum spontaneum, L.
" procerum, Roxb.
" officinarum, L., Sugarcane *cultivated, introduced.*
" Sara, Roxb.
" filifolium, Nees.
Erianthus Ravennæ, Beauv.
" japonicus, Beauv.

CRYPTOGAMS.

Filices or Ferns.

Woodsia elongata, Hk.
" lanosa, Hk.
Dicksonia appendiculata, Wall.
" scabra, Wall.
Davallia pulchra, Don.
" divaricata, Bl.
" immersa, Wall.
" nodosa, Hk.
Adiantum lunulatum, Burm.
" caudatum, L.
" Capillus-Veneris, L.

Filices or Ferns—(continued.)

Adiantum venustum, Don.
Cheilanthes Dalhousiæ, Hk.
" farinosa, Kaulf.
Onychium auratum, Kaulf.
" japonicum, Kunze.
Pellæa, calomelanos, Link.
Pteris longifolia, L.
" cretica, L.
" quadriaurita, Rez.
" aquilina, L.
" Wallichiana, Agdh.
Woodwardia radicans, Sm.
Asplenium, alternans, Wall.
" varians Hk. and Gr.
" viride, Huds.
" Trichomanes, L.
" planicaule, Wall.
" fontanum, Bernh.
" bulbiferum, Forst.
" tenuifolium, Don.
" Filix fœmina, Bernh.
" polypodioides, Mett.
" dilatatum, Wall.
" esculentum, Persl.
" Ceterach, L.
" australe, Brack.
Aspidium auriculatum, Sw.
" aculeatum, Sw.
" Thomsoni, Hk.
" aristatum, Sw.
" falcatum, Sw.
Nephrodium unitum, R. Br.
" prolixum, Bak.
" sparsum, Don.
" molle, Desv.
" cicutarium, Bak.
" polymorphum, Bak
" Filix-mas, Rich.
" cochleatum, Don.
" odoratum, Bak.
Oleandra Wallichii, Hk.
" neriiformis, Cav.
Polypodium erubescens, Wall.
" proliferum, Presl.
" lineatum, Colebr.
" amœnum, Wall.
" lachnopus, Wall.
" malacodon, Hk.
" trifidum, Don.
" Lingua Sw.
" stigmosum, Sw.
" fissum, Bak.
" flocculosum, Don.
" lineare, Thunb.
" normale. Don.
" membranaceum, Don.
" propinquum, Wall.
" juglandifolium, Don.
" quercifolium, L.
" himalense, Hook.
" leiorhizon, Wall.
Acrostichum virens. Wall.
Gymnogramme vestita, Hk.

Filices or Ferns—(concld.)

Gymnogramme Andersoni, Bedd.
" javanica, Bl.
" lanceolata, Hk.
" involuta, Don.
Osmunda Claytoniana, L.
Schizæa digitata, Sw.
Lygodium, scandens, Sw.
" japonicum, Sw.
Botrychium daucifolium, Wall.
" Lunaria, Sw.
" Virginianum, Sw.

Lycopodiaceæ.

Selaginella Jacquemontii, Spring.
" setacea, Spring.
" subulifolia, Spring.

Marsiliaceæ.

Marsilea qudrifolia, L.

Characeæ.

Chara veticillata, Roxb.

PLANTS OF KUMAON.[1]

Area under notice.

THE following list gives the names of all plants known to have been found in Kumaon, Garhwál and the Bhábar, three of the districts which are included in the Commissionership of Kumaon. Plants of the plains of India, plants growing in Tibet, and plants only found in the Independent States of Nepál and Tihri, do not appear in this list. The words, "common," "frequent," and "rare" have been employed to denote the comparative occurrence of the various species; but as the European stations of Almora, Naini Tál, and Ránikhet are all situated at a height of between 5,000 and 7,000 feet above the level of the sea, it will be easily understood that plants growing about that level are more likely to meet an observer's eye than plants which grow either at a very high, or at a very low elevation. Plants which are marked "rare" without any locality being given, are those which have been found by former observers, but which have never been seen growing within the limits of the division by Colonel Davidson, Mr. Waterfield or Dr. Watson. In the arrangement of the orders, genera, and species, Hooker's 'Flora of British India,' has been followed as far as published, that is to say, to the end of *Polypetalæ*. With regard to the other groups the books chiefly consulted have been Brandis' Forest Flora, Madden's Papers in the Journal of the Asiatic Society, Royle's Illustrations of Himalayan Botany, C. B. Clarke's Compositæ and Commelynaceæ, Steudel's Grasses, and Cyperaceæ, Hooker and Baker's Ferns, Mitten's Mosses.

Range of plants.

Synonyms have rarely been given except where the name adopted in the list is different from that given by Royle. Royle's Illustrations, published in 1839, is still a standard work on Himálayan Botany, and most of the plants figured in it are found in the Commissionership of Kumaon. There are, however, in Royle's book a certain number of plants which are common near Mussooree, where the book was written, but which are not found east of the Alaknanda river, the boundary between the Kumaon Commissionership and the Native State of Tihri. As examples of these Mussooree plants not found in Kumaon may be quoted—

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[1] This notice and list has been prepared for this volume by Mr. W. Watson, M.D., Deputy Sanitary Commissioner, Almora.

Dictamnus albus, Berberis Lycium, Rosa Lyelli, Sonerila tenera, Gentiana Kurroo, Picrorhiza Kurroo, Eremostachys superba.

On the other hand, the common *phalel* tree of Eastern Kumaon *(Bassia butyracea)* is apparently not found at Mussooree, as it is not mentioned by Royle as occurring there. The same remark applies to the very common and very beautiful *Silang* tree of Kumaon *(Olea acuminata)*. This tree, conspicuous from its sweet scented yellow blossoms, is never alluded to by Royle, so that he probably never met with it near Mussooree. It is found in Kumaon at all elevations from 3,000 to 7,000 feet. There are fine trees of it at Debi Dhúra at a height of 6,800 feet, and at Kapkot at a height of 3,400 feet.

The Kumaon Division includes a tract of country varying much in elevation. On the south, the Bhábar strip along the foot of the hills has a mean height of about 1,400 feet, whilst the passes that lead into Tibet have an elevation exceeding 18,000 feet. It might be expected that European forms would be more abundant towards these passes than in the Bhábar, and this, on the whole, is the case. There are, however, some European plants that are only found at low elevations and are never seen above 6,000 feet. The most common of these are :—*Ranunculus sceleratus, Geranium molle, Veronica Anagallis,* and *Verbena officinalis,* and it is difficult to assign an adequate reason for this phenomenon. Another remarkable fact connected with the montane flora is the eastern depression of many Himálayan plants. By this term is understood that plants which occur only at high elevations near Simla are found to grow at lower elevations at Mussooree and at still lower heights near Naini Tál. The following plants may be named as affording examples of eastern depression—

Eastern depression.

(*a*) The shrub *Coriaria nepalensis*, which gives its name to the station of Mussooree, is said by Royle not to grow under 5,000 feet at Mussooree. In Kumaon, however, it descends as low as 2,000 feet.

(*b*) *Hemiphragma heterophylla*, one of the *Scrophulariaceæ*, is never found at Simla below 10,000 feet, whilst it occurs in Kumaon at 7,000 feet, and is common there at 8,000 feet.

(*c*) The *Tilonj* oak, *Quercus dilatata*, is found at Simla about 7,000 feet, and near Naini Tál it grows abundantly down to 3,000 feet.

(*d*) *Dipsacus inermis* is one of the most common plants at Almora (5,500 feet), but is not found towards Simla at elevations below 8,000 feet.

(*e*) *Elsholtzia polystachya*, another common Almora plant, is found in Kumaon as low down as 4,000 feet, but near Simla it is not met with under 7,000 feet.

(*f*) *Senecio densiflorus* and *S. rufinervis*, with auricled leaves, are common all over Kumaon in November as low as 4,000 feet, but are not found in the neighbourhood of Simla under 7,000 feet.

It does not follow, and is not apparently true, that the higher limit of these plants follows the same law as their lower limit, but of the existence of the law of eastern depression of the lower limit of Himálayan plants, there can be little doubt. There is no example, so far as is known, of the converse, that is to say, of a plant confined to the higher ranges in Kumaon and growing at a low level near Simla.

With regard to certain plants being confined to particular rock formations, some interesting observations were made by Major Madden; thus he found that *Trigonella gracilis*, *Argyrolobium roseum*, and *Argyrolobium flaccidum* were confined to limestone rock. *Thymus serpyllum*, on the contrary, is only found on micaceous rock formations.

Introduced plants.

One of the most interesting facts for investigation in the Flora of any country is the number of introduced plants which have become wild. Of these, two may be noticed in Kumaon. The *deodár* tree, which is really a native of the Himálaya west of the Alaknanda, but being a sacred tree, it has for many generations been planted round almost every Kumaon temple. There are now magnificent groves at Gangolihát, Lohughát, Champháwat, and Bála Jageswar, and there is a tree at Wán in Garhwál which is certainly many hundreds of years old. Still the *deodár* is undoubtedly not indigenous. The other plant is weed and is of comparatively recent introduction. It is the *Erigeron canadense*, known to the natives as the locust weed, (*sallo)* because it is believed to spring from soil where locusts have alighted. This plant is not mentioned by Major Madden, who published his papers in the year 1840, and it has therefore in all probability made its appearance since that date. It is now a most common and a most troublesome weed in cultivated fields.

Indigenous drugs.

Many of the Kumaon plants are collected by the villagers and sold to herbalists to be used in medecine. The chief marts are Haldwáni, Barmdeo, and Ramnagar in Kumaon, and Kotdwára in Garhwál. The articles most in demand are the fruit of *Terminalia Chebula*, the roots of *Curcuma longa*, *Kyllingia triceps*, *Piper silvaticum*, and the various species of aconite; the bark of *Myrica sapida* and *Cinnamomum Tamala;* the rind of the fruit of the pomegranate; the powder from *Mallotus philippinensis*, and the various species of *chiretta*, all of which will be noticed hereafter in the chapter on 'Economic Botany.'

Dr. Watson desires to record and acknowledge the assistance that he has received in the preparation of this list from his friends Dr. King, Director of the Royal Botanical Gardens, Calcutta; Colonel Davidson, R.E., and Mr. W. Waterfield of the Bengal Civil Service.

PLANTS OF KUMAON.

DIVISION I.—POLYPETALÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—RANUNCULACEÆ.		
1	Clematis (Cheiropsis) Nepaulensis ...	...	December, near streams; rare.
2	„ „ montana ...	Ghantiáli ...	April, common.
3	„ „ barbellata ...	...	May; rare.
4	„ (Flammula) grata ...	Ghantiáli ...	Common.
5	„ „ Gouriana ...	...	Bhábar and valleys; October.
6	„ „ puberula ...	...	Colonel Davidson.
7	„ „ orientalis [parvifolia Edgeworth.]	...	Above 10,000 feet.
8	„ „ nutans ...	...	May. Common.
9	„ „ acuminata ...	...	Rare.
10	„ „ connata [amplexicaulis velutina and gracilis, Edgeworth.]	Ghantiáli ...	August, September. Very common.
11	„ „ Buchananiana,	Ghantiáli ...	October. Very common.
12	„ „ grewiæflora ...	...	Rare.
13	Anemone (Eriocephalus) vitifolia ...	...	June and July; common.
14	„ (Anemonanthea) obtusiloba,	Kakriya ...	May. Very common.
	„ [Govaniana and discolor] ...	...	Above 6,000 feet.
15	„ „ rupestris ...	...	June. Above 10,000 feet.
16	„ „ rivularis ...	...	Common.
17	„ (Omalocarpus) polyanthes,	...	Rare, 10,000 feet.
18	„ „ elongata ...	...	„ „
19	Thalictrum (Physocarpum) elegans ...	...	„ „
20	„ „ platycarpum ...	...	Rare. Badrináth.
21	„ „ cultratum ...	...	Rare.
22	„ „ Chelidonii ...	...	„
23	„ „ reniforme [neurocarpum, Royle.]	...	Common; high elevations, July.
24	„ „ pauciflorum ...	...	Frequent.
25	„ (Euthalictrum) Punduanum,	...	Common.
26	„ „ saniculæ forme,	...	On trees; autumn.
27	„ „ Javanicum ...	...	„
28	„ „ foliolosum ...	Penglá jari...	Very common, summer.
29	„ „ minus ...	„ ...	Frequent.
30	Callianthemum cachemirianum ...	...	Above 10,000 feet.
31	Adonis æstivalis	...	„ „
32	Ranunculus (Batrachium) aquatilis...	...	Bhím Tál.
33	„ (Hecatonia) sceleratus ...	Shím ...	Common up to 4,000 feet.
34	„ „ hirtellus ...	...	High elevations.
35	„ „ diffusus ...	...	Common.
36	„ „ lætus ...	Dainiya ...	Very common.
37	„ (Echinella) flaccidus ...	...	Rare.
38	„ „ arvensis ...	Ainwa ...	Common at low levels.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—RANUNCULACEÆ—(concluded).		
39	Oxygraphis glacialis	...	Above 15,000 feet.
40	„ polypetala	...	„ 10,000 „
41	Caltha palustris [Govaniana, Royle],	...	Common.
42	Trollius acaulis	...	Above 10,000 feet.
43	„ pumilis	...	„ 12,000 „
44	Isopyrum grandiflorum	...	„ „ „
45	Aquilegia vulgaris	...	Common.
46	Delphinium denudatum [pauciflorum, Royle.]	Múnila ...	„
47	„ cæruleum	...	Above 15,000 feet.
48	„ elatum	...	China hill 8,000 feet.
49	„ vestitum	...	„ 8,000 „
50	„ Cashmirianum	...	„ 10,000 „
51	„ Ajacis	Múnila ...	Naturalized.
52	Aconitum Lycoctonum	Bish ...	Above 8,000 feet.
53	„ palmatum	...	„ „ „
54	„ ferox	...	„ 10,000 „
55	„ Napellus	...	„ „ „
56	„ heterophyllum	Atís ...	„ 8,000 „
57	Actæa spicata	...	Rare.
58	Cimicifuga fœtida	...	„
59	Pæonia emodi	Bhúnya madín,	Young shoots eaten.
	ORDER 2.—DILLENIACEÆ.		
1	Dillenia indica	...	Rare.
	ORDER 3.—MAGNOLIACEÆ.		
1	Michelia Kisopa	Ban champa,	Common: Beripál and Ukhimath.
2	Schizandra grandiflora	Silangti ...	Frequent; Gágar.
3	„ propinqua	Sindráyan ...	Common.
	ORDER 4.—ANONACEÆ.		
1	Polyalthia Korinti [Guatteria Korinti, Madden.]	...	Swamps. Bhábar.
2	Anona squamosa	Beha ...	Ditto „
3	Miliusa velutina	...	Rare.
4	Saccopetalum tomentosum	Kangri ...	Kotdwára.
	ORDER 5.—MENISPERMACEÆ.		
1	Tinospora cordifolia	Gúrcha ...	Common.
2	Cocculus laurifolius	Tilbarapanyáli and kakra.	„ about 4,000 feet.
3	„ villosus	...	Rare.
4	Stephania elegans	...	„
5	„ rotunda [Roxburghiana]	Ganjára ...	Common.
6	Cissampelos Pareira [convolvulacea],	Pári ...	„

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 6.—BERBERIDEÆ.		
1	Holbœllia latifolia	Gophla	May, common, Ránikhet and Binsar.
...	„ *var.* angustifolia	...	...
2	Berberis (Mahonia) nepalensis	Gophla	Frequent, Thákil and Binsar.
3	„ (Euberberis) vulgaris	...	High elevations.
4	„ „ umbellata	...	Rare.
5	„ „ aristata	Chotra	Common. High elevations.
6	„ „ Lycium	...	Rare.
7	„ „ asiatica	Kilmora	Common.
8	„ „ Wallichiana	...	China hill, Colonel Davidson.
9	Podophyllum emodi	...	High elevations.
	ORDER 7.—NYMPHACEÆ.		
1	Nelumbium speciosum	Kanwál	Frequent, Buwálí pokar.
	ORDER 8.—PAPAVERACEÆ.		
1	Papaver dubium [glabrum, Royle]	Tákuvia	Common.
2	Argemone mexicana	Bhar bhánd,	Bhábar; introduced.
3	Meconopsis aculeata	Kánda	Above 10,000 feet
4	„ robusta	„	„ „ „
5	„ nipalensis	„	„ „ „
6	Stylophorum lactucoides	...	...
	ORDER 9.—FUMARIACEÆ.		
1	Dicentra Roylei	...	Rare.
2	„ scandens	...	Common.
3	Corydalis rutæfolia [diphylla]	...	„
4	„ cachemiriana	...	Above 9,000 feet.
5	„ crithmifolia	...	Rare.
6	„ elegans	...	Above 10,000 feet.
7	„ Govaniana	...	„ 8,000 „
8	„ ramosa	...	„ 12,000 „
9	„ sibirica [filiformis]	...	Common.
10	„ cornuta	Bhutkes	Very common,
11	„ chærophylla	...	Common, Binsar.
12	„ meifolia	...	Above 10,000 feet.
13	„ flabellata	...	„ 9,000 „
14	Fumaria parvifolia [Vaillantii]	Khairuwa	Very common.
	ORDER 10.—CRUCIFERÆ.		
	TRIBE ARABIDEÆ.		
1	Nasturtium officinale	Piriyá hálim,	Cultivated.
2	„ palustre	...	Common.
3	„ montanum	...	„
4	Barbarea vulgaris	...	„
5	Arabis glabra	...	Frequent.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 10.—CRUCIFERÆ—(continued).		
	TRIBE ARABIDEÆ—(concluded).		
6	Arabis alpina	...	Frequent.
7	„ amplexicaulis	Rái ghás ...	Common.
8	Cardamine hirsuta	..	...
9	„ impatiens	Sheliya ...	Very common.
10	„ macrophylla	...	Common.
	TRIBE ALYSSINEÆ.		
11	Alyssum maritimum	...	Naturalized.
12	„ canescens	...	Above 14,000 feet
13	Darba (Chrysodraba) alpina ...	...	„ 12,000 „
14	„ (Leucodraba) incana ...	...	„ 10,000 „
15	„ „ lasiophylla ...	...	„ 12,000 „
16	„ „ fladnitzensis ...	...	„ 13 000 „
	TRIBE SISYMBRIEÆ.		
17	Sisymbrium mollissimum ...	...	Above 8,000 feet.
18	„ himalaicum... ...	...	„ 10,000 „
19	„ Thalianum	...	Common.
20	„ rupestre	...	Above 8,000 feet.
21	„ strictum	...	Common.
22	„ Wallichii	...	„
23	„ sophia	Jauá ghás ...	„
24	„ Columnæ	...	Frequent.
25	„ Alliaria	...	Rare.
26	Eutrema primulæfolium	...	„
27	Erysimum hieracifolium ...	...	„
	TRIBE BRASSICEÆ.		
28	Brassica nigra	Káli sarson...	Cultivated.
29	„ campestris	...	„
	„ *var.* dichotoma	Jariya ...	„
	„ *var.* glauca, Rox ...	Rara, píla sarson.	„
	„ *var.* glauca, Royle ...	Dain toriya...	„ up to 11,000 feet.
30	„ trilocularis	...	Weed in fields.
31	„ juncea	Ríl ...	Cultivated.
32	Eruca sativa	Dúá ...	Common.
	TRIBE LEPIDINEÆ.		
33	Capsella Bursa-pastoris	...	Very common.
34	Lepidium sativum	Hálim ...	Common.
35	„ capitatum	...	Above 10,000 feet.
36	„ ruderale	...	Common, May and June, Almora.
	TRIBE THLASPIDEÆ.		
37	Megacarpæa polyandra	...	Above 10,000 feet.
38	Thlaspi arvense	Dhapriya ...	Common.
39	„ alpestre	...	Above 7,000 feet.
40	Iberidella Andersoni	...	„ 12,000 „

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 10.—CRUCIFERÆ—(concluded).		
	TRIBE. RAPHANEÆ.		
41	Raphanus sativus	Múli ...	Cultivated.
	ORDER 11.—CAPPARIDACEÆ.		
1	Cleome [Polanisia, Madden] viscosa...	...	Common, Bhábar and valleys.
2	Gynandropsis pentaphylla ...	...	Bhábar and valleys.
3	Capparis spinosa [*var.* leucophylla] ...	Ulta kánta ...	Common.
4	„ horrida ...	„ ...	Bhábar.
5	Mærua arenaria [Niebuhria oblongifolia, Royle, Ill.]	...	Rare.
	ORDER 12.—RESEDACEÆ.		
1	Reseda odorata	...	Naturalized.
	ORDER 13.—VIOLACEÆ.		
1	Viola biflora [reniformis] ...	...	Common.
2	„ Patrinii [cæspitosa] ...	...	„
3	„ diffusa	...	Rare
4	„ serpens [canescens, Wall] ..	...	Common.
5	„ kunawarensis	...	Above 11,000 feet.
	ORDER 14.—BIXINEÆ.		
1	Cochlospermum Gossypium ..	Kumbi, katira,	Common, Bhábar.
2	Flacourtia Ramontchi	Kandai ...	„
3	„ sepiaria	„ ...	„
4	Xylosma longifolium	Katári ...	Rare.
	ORDER 15.—PITTOSPORACEÆ.		
1	Pittosporum floribundum ...	...	Common, river banks.
2	„ eriocarpum	Gar siling ..	„
	ORDER 16.—POLYGALACEÆ.		
1	Polygala triphylla [glaucescens, Wall],	...	Common, autumn.
2	„ crotalarioides	...	Very common.
3	„ abyssinica	...	Rare.
4	„ leptalea [oligophylla, Wallich].	...	Common up to 4,000 feet.
5	„ persicariæfolia.. ...	...	August, frequent.
6	„ chinensis, [Rothiana, W. and A.	...	Common, Bhábar,
7	„ sibirica [elegans, Wallich],	...	„
	ORDER 17.—CARYOPHYLLACEÆ.		
	TRIBE SILENEÆ.		
1	Gypsophila cerastioides	...	Common about 10,000 feet.
2	Saponaria vaccaria	...	Introduced.
3	Silene inflata	...	Common.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 17.—CARYOPHILLACEÆ—(concluded).		
	TRIBE SILENEÆ—(concluded).		
4	Silene conoidea	...	Common.
5	,, gallica	...	Introduced.
6	,, Falconeriana	...	Common.
7	,, Stracheyi	...	Rare.
8	Cucubalus bacciferus	...	,,
9	Lychnis multicaulis	...	,,
10	,, inflata, Blinkworth ...	...	Very rare.
11	,, indica [fimbriata, Madden],	...	Very common.
	TRIBE ALSINEÆ.		
12	Cerastium dahuricum	...	Rare.
13	,, vulgatum [triviale, Madden].	...	Very common.
14	,, Thomsonii	...	Rare.
15	Stellaria (Schizostegium) crispata [monosperma, Don].	...	Common.
16	,, ,, paniculata [media, Wight.	...	Rare.
17	,, (Malachium) aquatica ...	...	,,
18	,, (Eustellaria) media [monogyna, Don].	...	,,
19	,, ,, semivestita ...	...	Painkhanda; common.
20	,, ,, Webbiana, [Leucostemma angustifolia, Wall].	...	Very common.
21	,, ,, latifolia, [leucostemma lat.folia, Wall].	...	Rare. Hánipáni.
22	,, (Larbrea) longissima]patens, Don].	...	,,
23	,, (Adenonema) decumbens...	...	Above 11,000 feet.
24	Arenaria (Alsine) foliosa ...	...	Painkhanda; common, June.
25	,, (Eremogone) festucoides ...	...	Rare.
26	,, (Euthalia) serpyllifolia ...	...	Common, May & June.
27	,, ,, orbiculata ...	...	,,
28	,, (Lepyrodiclis) holosteoides,	...	,,
29	,, Benthami	...	Rare.
30	Spergula arvensis	...	Introduced.
31	,, pentandra [Arenaria flaccida, Roxb.]	...	,,
	TRIBE POLYCARPEÆ.		
32	Drymaria cordata	...	Common.
33	Polycarpæa corymbosa	...	,,
	ORDER 18.—PORTULACEÆ.		
1	Portulaca oleracea	Lúniya-kulfa,	Common.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 19.—TAMARISCINEÆ.		
1	Tamarix gallica	...	Bhábar.
2	„ dioica	...	„
3	Myricaria germanica	...	Frequent, above 10,000 feet.
4	„ elegans	...	Frequent, above 11,000 feet.
	ORDER 20.—HYPERICINEÆ		
1	Hypericum (Androsæmum) cernuum,	Ulua-bena ...	Common. April.
2	„ cardifolium ...	...	Rare, Ránni.
3	„ lysimachioides ...	...	Frequent above 8,000 feet.
4	„ patulum [uralum, Don].	...	Common, September.
5	„ (Euhypericum) perforatum.	...	„ „
6	„ elodeoides	...	„ August, and September.
7	„ nepaulense	...	„ August, and September.
8	„ (Brathys) japonicum [pusillum].	...	Low elevations.
	ORDER 21.—TERNSTRÆMIACEÆ		
1	Eurya acuminata	Deura ...	Common
2	Actinidia [Trochostigma, Madden] callosa.	...	Bhábar and banks of Sarju.
3	Saurauja nepaulensis	Goganá ...	Common.
4	Camellia thea	Chá ...	Introduced.
	ORDER 22.—DIPTEROCARPEÆ.		
1	Shorea robusta	Sál Sákhu ...	Common up to 4,500 feet, March.
	ORDER 23.—MALVACEÆ.		
	TRIBE MALVEÆ.		
1	Malva verticillata	...	Frequent.
2	„ silvestris, [mauritiana, Madden].	Tilchoni ...	Gardens and wild.
3	„ rotundifolia		Common.
4	„ parviflora	...	Up to 2,000 feet.
5	Sida rhombifolia	Bhoa Kálabali	Common.
6	„ cordifolia	...	„
7	Abutilon polyandrum	...	Bhábar and up to 3,000 feet.
8	„ indicum	...	
	TRIBE URENEÆ.		
9	Urena lobata	Sújiya Chatkura.	Common, banks of streams.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 23.—MALVACEÆ—(continued).		
	TRIBE HIBISCEÆ.		
10	Hibiscus (Furcaria) furcatus ...	.	Introduced.
11	„ (Lagunea) solandra ...	...	Common.
12	„ (Abelmoschus) ficulneus ...	...	„
13	„ pungens	Háo Kapásya	„
14	„ cancellatus	„ ...	„
15	Thespesia lampas	Kapásya ...	
	TRIBE BOMBACEÆ.		
16	Kydia calycina	Patá ...	Common, September.
17	Bombax malabaricum [Bombax heptaphyllum, Roxb.]	Semal ...	„ Bhábar, up to 4,800 feet.
	ORDER 24.—STERCULIACEÆ.		
1	Sterculia urens	Katíra ...	Bhábar.
2	„ villosa	Udyál ...	„
3	„ (Firmiana) fulgens [Wallichii, Madden.]	Bodalá ...	Common.
4	Helicteres isora	Maror phal,	Bhábar, May,-September.
5	Pterospermum acerifolium ...	Muchkunda,	Introduced.
6	„ lanceæfolium [P. suberifolium, Madden]	„ ...	Bhábar.
7	Melochia corchorifolia, [Riedleia corchorifolia, Dec.]	...	Up to 4,000 feet.
8	Waltheria indica, [Melochia corchorifolia, Wall.]	...	„ „
	ORDER 25.—TILIACEÆ.		
1	Grewia oppositifolia	Bhekla, bhengál.	Common.
2	„ tiliæfolia	...	Frequent, valleys.
3	„ asiatica [elastica, Royle, III.]	Pharsiya ...	Common, cultivated.
4	„ sapida [nana, Wall] .	„ ...	Common.
5	„ scabrophylla [sclerophylla, Wall]	Gar bheli ...	„
6	„ laevigata [didyma, Roxb] ...	Bhimul ...	„
7	„ polygama	...	Bhábar.
8	Triumfetta pilosa [oblongata, Wall]	Leshwa, kumariya.	Common.
9	„ rhomboidea [angulata, Wall.]	Chat kura ...	Up to 4,000 feet.
10	Corchorus fascicularis ? ...	...	Introduced.
11	„ acutangulus ? ...	...	„
12	Elæocarpus Varunua	Ja'pai ...	Rare.
	ORDER 26.—LINEÆ.		
1	Linum usitatissimum	Alsi ...	Introduced.
2	Reinwardtia trigyna	Pyúra ...	Very common, March.
3	„ tetragyna	...	Rare.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 27.—MALPIGHIACEÆ.		
1	Hiptage madablota	...	March; common up to 3,000 feet.
2	Aspidopterys Wallichii [Hiræa nutans, Wall].	...	June: frequent up to 4,000.
	ORDER 28.—ZYGOPHYLLEÆ.		
1	Tribulus terrestris	...	Common.
	ORDER 29.—GERANIACEÆ.		
1	Geranium pratense	...	Rare, Painkanda.
2	„ collinum	..	„
3	„ palustre ? [grandiflorum, Edgeworth]	...	„ Mána Pass.
4	„ Wallichianum	...	Common, Naini Tal and Binsar, July.
5	„ Grevilleanum [eriostemon, Don]	...	„
6	„ nepalense	...	Common, May, June.
7	„ polyanthes	. .	Rare.
8	„ rotundifolium	...	„
9	„ molle	...	February. Banks of Ganges up to 1,500 feet.
10	„ Robertianum	...	„
11	„ lucidum	...	Common.
12	„ ocellatum [bicolor, Royle, Ill]	Ankrí ...	Very common, April, May,
13	Tropæolum majus	..	Introduced.
14	Oxalis corniculata	Chalmori ...	Very common.
15	„ acetosella	...	Rare, Pindari, April.
16	Biophytum sensitivum	...	Common up to 4,000 feet.
17	„ Reinwardtii	...	„ „
18	Impatiens (Brevicapsulæ) Balsamina,	...	Gardens.
19	„ (Longicapsulæ Roylei *var.* moschata, Edge.	...	Common.
20	„ Thomsoni	...	12,000 feet.
21	„ sulcata [gigantea, Edge.],	...	Frequent.
22	„ amplexicaulis	...	Rare.
23	„ scabrida [tricornis, Lind, Hamiltoniana, Don].	...	Common, May, June.
24	„ bicornuta	...	Rare.
25	„ amphorata	...	Common, autumn.
	var umbrosa, Edge, [bi.color, Royle, Ill.]	...	„
26	„ racemosa	...	Frequent.
27	„ laxiflora	...	„
28	„ micranthemum	...	Rare.
29	„ brachycentra	...	Frequent, summer.
30	„ glauca	...	Rare, Diwáli.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 30.—RUTACEÆ.		
	TRIBE RUTEÆ.		
1	Bœnninghausenia albiflora, [Ruta albiflora, Wall.]	Piau ghás and upanyá ghás.	Very common, autumn.
	TRIBE ZANTHOXYLEÆ.		
2	Zanthoxylum alatum, [Z. hostile, Wall.]	Timur and tejbal.	Common.
3	„ acanthopoidum [hostile, Wall.]	Simur ...	Rare, Budh Jageswar.
4	„ oxyphyllum ...	...	Frequent, Gágar.
5	„ Budrunga ..	...	Rare.
	TRIBE TODDALIEÆ.		
6	Toddalia aculeata	Khaseru ...	Bhábar and valleys.
7	Skimmia [Limonia, Wall. AnqueTilia Deco.] Laureola.	Nehar, kastúri, gúral pata.	Very common.
	TRIBE AURANTIEÆ.		
8	Glycosmis pentaphylla	Potla ...	Common.
9	Murraya exotica	Juti ...	„
10	„ (Bergera) Kœnigii ...	Gani ...	Very common.
11	Clausena pentaphylla		Bhábar.
12	Limonia acidissima [L. crenulata, Roxb.]	... ...	„
13	Citrus medica	Bijaura ...	„
	var. limonum	Jamira ...	„
14	„ aurantium	...	Rare.
15	Feronia Elephantum	Kait ...	Bhábar.
16	Ægle Marmelos	Bel ...	„
	ORDER 31.—SIMARUBEÆ.		
1	Picrasma quassioides	...	Valleys ; frequent.
	ORDER 32.—OCHNACEÆ.		
1	Ochna pumila	...	Rare.
	ORDER 33.—BURSERACEÆ.		
	TRIBE AURANTIEÆ.		
1	Boswellia serrata [thurifera, Roxb.]	Sale, gugar...	Bhábar.
	var. glabra	Gugai ...	„
2	Garuga pinnata	Kharpat ...	„
	ORDER 34.—MELIACEÆ.		
1	Melia Azadirachta [indica] ...	Ním ...	Introduced. Bhábar.
2	„ Azedarach [sempervirens Roxb].	Betain ...	Common.
3	Heynea trijuga, [Zanthoxylon connaroides, W. & A.]	...	Bhábar.
4	Cedrela Toona	Tún ...	Valleys.
5	„ serrata	Dál ...	Very common.

DIVISION I.—POLYPETEÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 35.—OLACINEÆ.		
1	Olax scandens		Bhábar.
2	,, nana	..	Frequent.
	ORDER 36.—ILICINEÆ.		
1	Ilex dipyrena	Kandáli	Very common.
2	,, odorata	Gar-kaula, garahun.	Frequent.
3	,, excelsa	Kandali ..	Common
	ORDER 37.—CELASTRINEÆ		
1	Euonymus grandiflorus [lacerus, Don],	..	Bhábar, & to 3,000 feet.
2	,, tingens	Kasuri ...	Frequent, April.
3	,, fimbriatus	.	Rare, 9,000 feet, April.
4	,, frigidus	...	,, 10,000 ..
5	,, echinatus	..	Frequent, April
6	,, pendulus [japonicus, Wall].	...	,,
7	,, Hamiltonianus	Agnu ..	Common.
8	Celastrus paniculata [nutans, Roxb]	Malkágni ..	March. Bhim Tál.
9	Gymnosporia rufa. [Celastrus rufa, Brandis.]	..	Rare.
10	,, Royleana, [C. spinosus, Lam.].	Gwala-dárim.	Common.
11	,, montana [C. senegalensis, Lam.]	.	Rare.
12	Elæodendron glaucum [Roxburghii, W. & A., Neerija dichotoma, Roxb].	Shauria jamrási and dehbri	Common A white aphis feeds on this tree.
13	Microtropis discolor	..	Frequent.
	ORDER 38.—RHAMNACEÆ.		
1	Ventilago calyculata [madraspatana, Roxb.]	Rakt pita, kála lag	Common.
2	Zizyphus jujuba	Bair .	Cultivated.
3	,, nummularis	,, .	..
4	,, vulgaris	,, .	..
5	,, oxyphylla	,, ...	Frequent up to 6,000 feet.
6	,, xylopyrus	.. ..	Bhábar.
7	,, rugosa	,, ...	,,
8	Berchemia floribunda	Kála lag	Frequent
9	,, flavescens	.	,,
10	,, Edgeworthii		Rameshwar.
11	Rhamnus dahuricus [virgatus, Roxb.]	Chadua ...	Common, April
12	,, purpureus	.	Common.
13	,, triqueter	Ghont ...	,,
14	,, procumbens	..	About 7,000 feet : on limestone.
15	Hovenia dulcis	...	Rare : cultivated
16	Sageretia oppositifolia	Aglaia ...	Common.
17	Gouania leptostachya	Kála lag ...	,,
18	,, nepalensis	...	Bhábar
19	Helinus lanceolatus	...	Common : valleys.

DIVISION.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note
	ORDER 39.—AMPELIDEÆ.		
1	Vitis (Simplicifoliæ) quadrangularis [Cissus edulis].	Harjora ...	Bhábar.
2	„ pallida ...	...	Rare.
3	„ repanda [rosea, Royle Ill.]	...	Frequent; Bhábar.
4	„ adnata	...	Rare.
5	„ pedicellata	...	„
6	„ lanata	Purrin ...	Common, May.
	„ *var.* rugosa	Assánja ...	„ July.
7	„ latifolia	Pan-laguli ..	„ Bhábar.
8	„ vinifera	...	Wild?
9	„ parvifolia	Barain ...	Common.
10	„ (Trifoliatæ) carnosa ...	...	Bhábar.
11	„ [Ampelopsis, Wight] himalayana.	Chappar-tang.	Common.
12	„ divaricata [tomentosa, W. and A.]	Amila ...	„
13	„ (Digitatæ) obtecta ...	...	„
14	„ (Pedatæ) capriolata [Cissus serrulata, Roxb.]	...	„
15	„ lanceolaria [Cissus feminea, Roxb.]	Panj-pata . .	Ránibagh.
16	Leea (Simplicifoliæ) macrophylla ...	...	Frequent
17	„ (Pinnatæ) alata ...	...	„
18	„ aspera ...	Kurmali ...	Common.
19	„ (Bipinnatæ) sambucina ...	...	Rare.
	ORDER 40.—SAPINDACEÆ.		
	TRIBE SAPINDEÆ.		
1	Cardiospermum Halicacabum ..	..	Bhábar.
2	Æsculus (Pavia) indica ...	Pánkar, pangri.	Common.
3	Schleichera trijuga	Kusám ...	Bhábar.
4	Sapindus Mukorossi	Rita. ...	Rare.
	„ *var.* detergens ...	...	Common.
	„ *var.* acuminatus ...	...	
5	Acer (Integrifoliæ) oblongum ...	Patangtiya...	Common; cups are made of the wood.
6	„ lævigatum	...	Common.
7	Acer (Trilobatæ) pentapomicum ...	...	[illegible]
8	„ (Quinquelobatæ) cæsium ...	Kilu ...	Frequent.
9	„ villosum [sterculacium Wall?]...	...	8,000 feet; cups made of the wood.
10	„ candatum [pectinatum Wall.]...	...	10,000 feet.
11	*„ (Septemlobatæ) pictum [cultratum, Wall.]	...	Very common.
	TRIBE DODONEÆ.		
12	Dodonæa viscosa	...	Rare: Bhábar.
	TRIBE MELIANTHEÆ.		
13	Melianthus major	...	Introduced.

DIVISION I.—POLYPETALÆ—(*continued*)

No.	Scientific name.	Vernacular name.	Note.
	ORDER 40.—SAPINDACEÆ—(concluded).		
	TRIBE STAPHYLEÆ.		
14	Staphylea emodi	Chitra ...	Frequent: Gágar and Siáhi Dabi.
	ORDER 41.—SABIACEÆ.		
1	Meliosma dilleniæfolia	Gwep ...	Common about 7,000 feet.
2	„ pungens	Gardar ...	Frequent; banks of streams.
3	Sabia campanulata	Bakal pata...	Common.
4	„ parviflora	...	„ about 5,000 feet.
5	„ paniculata	...	„ Bhábar.
	ORDER 42.—ANACARDIACEÆ.		
1	Rhus (Simplicifoliæ) cotinus ...	Tung-ami ...	Very common
2	„ (Trifoliatæ) parviflora ...	Ranel ...	„
3	„ (Impari pinnatæ) semialata ...	Dakmila ...	Common.
4	„ Wallichii [vernicifera, Royle].	Bholiao ...	„
5	„ succedanea [acuminata, Dec.] ..	Titari ..	„
6	Pistacia integerrima, [Rhus integerrima, Wall]	Kakar singi,	Valleys; common.
7	Odina Wodier	Jhingho ..	Common; valleys
8	Semecarpus Anacardium ..	Bhiláwa ...	Bhábar.
9	Mangifera indica	Am ...	Common; valleys.
10	Buchanania latifolia	Pial ...	Bhábar.
11	Spondias mangifera	Amra ...	„ and valleys.
	ORDER 43.—CORIARIACEÆ.		
1	Coriaria nepalensis	Mansuri mokola.	Common.
	ORDER 44.—MORINGEÆ.		
1	Moringa pterygosperma... ...	Sainjan ...	Common; Bhábar.
	ORDER 45.—LEGUMINOSÆ.		
	TRIBE PODALYRIEÆ.		
1	Piptanthus nepalensis	Shalgari ..	Above 8,000 feet.
2	Thermopsis barbata	...	„ 10,000 „
	TRIBE GENISTEÆ.		
3	Argyrolobium flaccidum [Cytisus flaccidum, Royle]	...	Common, July and August, on limestone.
4	„ roseum	...	„ „
5	Crotalaria (Diffuse) humifusa ..	Gungri ...	Common.
6	„ „ hirsuta ...	...	Bhábar.
7	„ (Alatæ) alata	Gungri ...	Common, autumn.
8	„ (Calycinæ) mysorensis ...	...	Valley.
9	„ „ albida ...	...	Common.
10	„ „ calycina ...	..	Frequent.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note
	ORDER 45.—LEGUMINOSÆ—(continued).		
	TRIBE GENISTEÆ—(concluded).		
11	Crotalaria (Calycinæ sessiliflora [anthylloides, Lam].	...	Common.
12	„ (Erectæ) sericea ...	Gungri ...	Valleys, common.
13	„ (Eriocarpæ) tetragona ...	...	„
14	„ (Trifoliolatæ) medicaginea,	...	Very common.
15	„ „ incana ...	...	Naturalized.
	TRIBE TRIFOLIEÆ.		
	SECTION DIGITATÆ.		
16	Trifolium pratense	...	Cultivated ; rare.
17	„ repens	...	„ common.
18	Parochetus communis [oxalidifolia, Royle.]	...	Common, damp ground.
	SECTION PINNATÆ.		
19	Trigonella Fœnum-græcum ...	Methi ...	Cultivated.
20	„ polycerata [incisa, Royle]	...	„
21	„ gracilis	...	July, on limestone.
22	„ pubescens	...	Col. Davidson.
23	„ corniculata	...	Frequent.
24	„ emodi	...	Col. Davidson.
25	Melilotus parviflora	...	Cultivated.
26	„ alba	Garila ...	Common.
27	Medicago lupulina	...	„
28	„ denticulata	...	„
	TRIBE LOTEÆ.		
29	Lotus corniculatus	...	Very common.
	TRIBE GALEGEÆ.		
30	Cyamopsis psoralioides	...	Bhábar.
31	Indigofera (Sphæridiophora) linifolia	...	„
32	„ (Paucifoliolatæ) trifoliata ...	...	„
33	„ „ trita ...	...	Common.
34	„ (Multifoliolatæ) hirsuta ...	Náná-sakina,	
35	„ Gerardiana [heterantha, Wall.	Múa-sakina...	Very common, May.
36	„ „ atropurpurea ...	Kálá-sakina,	Common, August.
37	„ „ pulchella [arborea, Roxb].	Sakina ...	Very common, March.
38	„ „ Dosua [heterantha, Wall.	Sakina ...	Very common, May, June.
39	Colutea arborescens, *var.* nepalensis,	...	Above 10,000 feet, July, August.
40	Mellettia auriculata [Robinia macrophylla, Roxb].	Gojha ...	Very common; valleys, May.
41	Tephrosia candida	Lehtia ...	Bhábar. Leaves used to poison fish.
42	„ purpurea	...	Bhábar.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45.—LEGUMINOSÆ—(continued).		
	TRIBE GALEGEÆ (concluded).		
43	Sesbania ægyptiaca	Jait ...	Cultivated.
44	Caragana pygmæa [Genista, versicolor, Royle].	...	Common above 10,000 feet.
45	" Gerardiana [Caragana spinosissima, Royle.]	Dámá ...	" 8,000 feet, May.
46	" polyacantha	" ...	Rare.
47	" brevispina	" ...	Common above 8,000 feet.
48	" crassicaulis	...	" " 12,000 feet.
49	Guldenstædtia himalaica ...	Dámá ...	" " 11,000 feet.
50	Astragalus (Pogonophace) trichocarpus [sesbanoides, Royle].	...	Common.
51	" (Pololotus) hosackioides ...	...	Common.
52	" (Hypoglottis) himalayanus ...	...	Above 10,000 feet.
53	" " Maddenianus ...	...	" "
54	" " leucocephalus ...	...	Common.
55	" (Phaca) chlorostachys ...	...	"
56	" " *var.* trichocarpoides Kurz,	...	W. Waterfield, Naini Tál.
57	" " emodi	...	Above 10,000 feet.
58	" graveolens	...	Frequent.
59	" (Myobroma) Candolleanus ...	...	Above 8,000 feet.
60	" (Ægacantha) polyacanthus ...	...	Frequent.
	TRIBE HEDYSAREÆ		
	SECTION EXSTIPELLATÆ.		
61	Onobrychis sativa	...	Cultivated.
62	Lespedesa (Eulespedeza) sericea ...	...	Common.
63	" " Gerardiana,	..	Very common.
64	" (Oxyrambhia) macrostyla,	...	Common.
65	" " eriocarpa ...	...	"
66	Hedysarum kumaonense ...	...	Rare; *found by Strachey and Winterbottom.*
67	Zornia diphylla [angustifolia, D.C.]	...	Common.
68	Smithia sensitiva	...	Bhábar.
69	" geminiflora	...	"
70	" ciliata	...	Common near streams.
71	Æschynomene indica	...	Up to 4,000 feet.
	SECTION STIPELLATEÆ.		
72	Uraria picta	...	Common.
73	" crinita	...	"
74	" lagopus	...	"
75	" prunellæfolia	...	Valleys.
76	Alysicarpus (Microcalycinæ) vaginalis.	...	Common to 4,000 feet.
77	" (Microcalycinæ) bupleurifolius.	...	" "

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45.—LEGUMINOSÆ—(continued).		
	TRIBE HEDYSAREÆ—(concluded).		
	SECTION STIPELLATÆ—(concluded).		
78	Alysicarpus (Microcalycinæ) rugosus,	Saindan asainda.	Common to 4,000 feet.
79	Ougeinia dalbergioides [Dalbergia oujeinensis, Roxb.]	...	Up to 4,000 feet, March.
80	Desmodium (Phyllodium) pulchellum,	...	Bhábar.
81	„ (Pteroloma) triquetrum,	...	Common.
82	„ (Scorpiurus) laxiflorum,	...	„ Naini Tál.
83	„ (Podocarpium) podocarpum.	...	Rare.
84	„ (Dollinera) floribundum [multiflorum D. C.]	...	Very common, August.
85	„ „ oxyphyllum [polycarpum, Wall.]	...	Common ; Binsar „
86	„ „ tiliæfolium [nutans, Wall., argenteum Wall.]	...	Very common, July.
87	„ (Heteroloma) Gangeticum,	...	Valleys.
88	„ „ latifolium ...	...	Frequent.
89	„ „ sequax ...	...	„
90	„ „ concinnum [penduliflorum, Wall.]	...	Common up to 7,000 feet.
91	„ (Nicolsonia) polycarpum D.C. [angulatum, Wall.]	...	„
92	„ (Sagotia) triflorum ...	...	Very common, autumn.
93	„ „ parviflorum ...	...	„
94	„ (Pleurolobium) gyrans ...	...	Common.
95	„ „ gyroides...	...	Bhábar.
	TRIBE VICIEÆ.		
96	Acrus precatorius	Gunchi rakti,	Bhábar and valleys.
97	„ pulchellus	Laguli-imli,	„
98	Cicer arietinum	Chana ...	Cultivated ; Bhábar.
99	„ soongaricum [microphyllum, Royle.]	...	About 12,000 feet ; rare.
100	Vica (Ervum) tetrasperma ...	...	Rare.
101	„ „ hirsuta ...	Kuri ...	In cultivated fields.
102	„ (Cracca) tenera	...	Frequent ; Adwani, April.
103	„ „ mollis	...	High levels ; rare.
104	„ „ pallida	...	Common.
105	„ „ rigidula	...	Rare.
106	„ (Euvicia sativa	Kur-kosha ...	Cultivated.
107	Lathyrus (Kalathyrus) aphaca ...	Ghora-kolon,	Common.
108	„ „ sativus ...	Matar ...	Cultivated.
109	„ „ sphæricus [angulatus, Royle.]	Ningla-kosha,	Common.
110	„ (Orobus) lutens ...	...	Frequent.
111	Pisum sativum	Kolai ...	Cultivated.
112	„ arvense	„	Cultivated and wild.

DIVISION I.—POLYPETALÆ— (*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45.- LEGUMINOSÆ - (continued).		
	TRIBE PHASEOLEÆ.		
	SECTION GLYCINEÆ.		
113	Shuteria vestita, *var* involucrata	...	Common.
	„ *var*. densiflora	..	Rare.
114	Dumasia villosa	..	Common.
115	Glycine soja [Soja hispida, Mœnch,]	Bhat ...	Cultivated; very common.
	SECTION ERYTHRINEÆ		
116	Mucuna atropurpurea	Baldaka ...	Bageshwar.
117	„ pruriens	Goncha ...	Valleys; common, May.
118	Erythrina indica	Rungra ...	February; Bhábar.
119	„ resupinata	...	Frequent; Háwalbagh, March and October.
120	„ suberosa	Rungra ...	March, up to 4,000 feet.
121	„ arborescens	„	August, common.
	SECTION GALACTIEÆ.		
122	Spatholobus Roxburghii [Butea parviflora, Roxb.]	Maola ...	Bhábar.
123	Butea frondosa	Dhák ...	Up to 4,000 feet.
124	Butea superba	...	Near Taili Mainari hill Loch, September.
125	Pueraria tuberosa	Billi-kand ...	Very common, March, April.
126	„ Stracheyi	..	Rare: Kálimandi, 7,300 feet.
	SECTION EUPHASEOLEÆ.		
127	Phaseolus vulgaris	...	Cultivated; Bhábar gardens.
128	„ trilobus	Chhihin ...	„ Bhábar.
129	„ aconitifolius	Moth .	„ Bhábar.
130	„ mungo	Múng .	„ not common.
	„ „ *var* radiatus ..	Urd ...	„ common.
131	„ calcaratus [torosus, Roxb.]	Gurush .	„ and wild red and white varieties.
132	Vigna (Euvigna) catiang [Dolichos sinensis, Linn.]	Riansh ...	„ common, three varieties.
	„ „ *var*. sinensis ...	Lobiya ...	„
133	„ (Plectropis) vexillata [Phaseolus angustifolius, Wall.]	Ban-mung ...	Very common, autumn.
134	Pachyrrhizus angulatus	...	Cultivated; Bhábar, root edible.
135	Dolichos Lablab	Shími ...	Gardens, cultivated up to 7,000 feet.
136	„ biflorus [uniflorus, D. C.]	Gahat ...	Cultivated up to 3,000 feet.
137	„ falcatus	Gahatiya? ...	Common.

DIVISION I.—POLYPETALÆ (*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45. LEGUMINOSÆ (continued).		
	TRIBE PHASEOLEÆ (concluded).		
	SECTION CAJANEÆ.		
138	Atylosia (Atylia) mollis	...	Common.
139	,, ,, grandiflora	...	Rare; Bageshwar.
140	,, ,, [Cantharospermum] scarabæoides	..	Common: Bhábar and outer hills.
141	,, ,, platycarpa,	...	Rare.
142	Cajanus flavus	Arhar	Cultivated; Bhábar.
143	Eriosema chinense [Crotalaria tuberosa, Don.]	..	Common: Simtola hill.
144	Rhynchosia pseudo-cajan	Shuli, phúsarpata.	,,
145	,, minima		Low elevations; rare.
146	,, himalensis	...	,, ,,
147	Flemingia (Ostryodium) strobilifera.	...	Very common.
	,, *var.* fruticulosa	..	,,
148	,, ,, Chappar	...	Rare.
149	,, (Chalaria) paniculata	...	At low elevations.
150	,, (Flemingiastrum) congesta [semialata].	Bhatua	Common.
	,, ,, *var.* nana	...	Common.
151	,, (Rhynchosioides) vestita.	Muskila	Edible tuber; common.
	TRIBE DALBERGIEÆ.		
	SECTION ALTERNIFOLIOLATÆ.		
152	Dalbergia Sissoo	Sisu	Bhábar and valleys.
153	,, rimosa	...	,, ,,
154	,, lanceolaria [frondosa, Roxb.]	...	Frequent.
155	,, volubilis	Bhatia	Common
156	Pterocarpus marsupium	Bijai-sal	Near Barmdeo.
	SECTION OPPOSITIFOLIOLATÆ.		
157	Pongamia glabra	Pit pápar	Bhábar, April
158	Derris robusta	Baro	Up to 5,000 feet
	TRIBE SOPHOREÆ		
159	Sophora mollis [Edwardsia mollis, Royle].	Pahár-gungri,	Very common, March.
	TRIBE CÆSALPINIEÆ.		
160	Cæsalpinia [Guilandina] Bonducella,	Karonj	Up to 2,500 feet
161	,, [Poinciana] pulcherrima,	Krishna chura.	Garden.
162	,, ,, sepiaria	Aira	Common.
163	Parkinsonia aculeata	Wiláyati kikar.	Introduced.
164	Poinciana regia	...	Gardens; rare.

DIVISION I.—POLYPETALÆ—(continued).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45.—LEGUMINOSÆ—(continued).		
	TRIBE CASSIEÆ.		
165	Cassia (Fistula) Fistula ...	Rajbrikah, kitota.	May, June, up to 4,000 feet.
166	„ (Senna) occidentalis ...	Banár ...	Bhábar.
167	„ „ Sophera [purpurea, Roxb],	„ ...	„
168	„ „ Tora	„ ...	Common.
169	„ „ angustifolia [lanceolata, Royle.]	Sanna, makki.	Cultivated; Bhábar.
170	„ (Psilorhegma) glauca [arborescens, Roxb.	...	Bhábar.
171	„ (Lasiorhegma) Absus [coccinea, Wall.]	Banár ..	Common.
172	„ „ pumila	Silpatiya ...	„
173	„ „ mimosoides ...	„ ...	Very common.
...	„ „ *var.* dimidiata ...	„ ...	Common.
...	„ „ *var.* Wallichiana... ..	„ ...	„
	TRIBE AMHERSTIEÆ.		
174	Saraca indica [Jonesia asoka, Roxb.]	Asok ..	Introduced; Sitaban, Bhábar.
	TRIBE BAUHINIEÆ.		
175	Bauhinia (Decandræ) racemosa [parviflora Vahl.]	...	Up to 5,000 feet, common, April.
176	„ „ malabarica ...	Amli ...	Rare, October.
177	„ (Triandræ) retusa [emarginata, Wall.]	Kándla ...	Common, September.
178	„ „ Vahlii ...	Málu ...	Very common, April, May.
179	„ „ purpurea ...	Khairwál ...	Bhábar and valleys, October.
180	„ (Pentandræ) variegata ...	„	Common, April.
...	„ „ *var.* candida, ...	...	„
	TRIBE MIMOSEÆ.		
181	Entada scandens	...	Rare.
182	Parkia biglandulosa ...	...	Cultivated; Bhábar.
183	Leucæna glauca [Acacia frondosa,... D. C.]	...	Common, valleys, July.
184	Mimosa pudica	Lajwanti ..	Naturalized, Bhábar.
185	„ rubicaulis [octandra, Roxb.],	Agla ...	August; common up 4,000 feet.
	TRIBE ACACIEÆ.		
186	Acacia (Globiferae) Farnesiana ...	Wiláyati babúl.	Bhábar and valleys.
187	„ „ arabica ...	Babúl ...	„
188	„ „ eburnea ...	Bhes ...	Banks of streams.
189	„ (Spicatae) Catechu ...	Khair ...	Very common; Bhábar.
190	„ „ molesta ...	Philai ...	Rare, Bhábar.
191	„ „ lenticularis ...	Khain ...	Barmdeo.
192	„ (Vulgares) concinna [rugata, D.C],	Ban-ritha ...	Bhábar.
193	„ „ Intsia [Cæsia, Linn.]	Katrar ..	Very common, Bhábar.
194	„ „ pennata ...	Agla	„ „

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 45.—LEGUMINOSÆ—(concluded).		
	TRIBE INGEÆ.		
195	Albizzia (Multifoliolatae) Lebbek ...	Tantiya, halsís	Common, April, June.
196	„ „ odoratissima ...	Siris ...	Bhábar, April, June.
	„ „ *var.* mollis ...	„ ...	„ „
197	„ „ procera ...	Baro ...	„ May
198	„ „ Julibrissin ...	Lál siris ...	Up to 5,000 feet, May.
199	„ „ stipulata [Smithiana, Wall.	...	Up to 4,000 feet, May.
200	„ Páucifoliolatae) lucida ...	...	Bhábar, April.
201	Pithecolobium (Unguiscati) dulce ...	Wiláyati imli, Dakhni babúl.	Gardens, Bhábar.
202	„ Clypearia) bigeminum	Kachlora ...	Up to 3,000 feet, April.
	ORDER 46.—ROSACEÆ.		
	TRIBE PRUNEÆ.		
1	Prunus (Amygdalus) persica ...	Aru ...	Cultivated; very common.
2	„ (Armeniaca) armeniaca ...	Chuáru and zardáru.	„
3	„ (Cerasus) avium ...	...	Cultivated up to 6,000 feet.
4	„ „ cerasus ...	...	„
5	„ „ Jacquemontii ...	Padam puya	Rare, Malári, Edgeworth.
6	„ „ Puddum ...	...	Very common, November.
7	„ (Euprunus) communis *var.*, domestica *var.*	Bhotiya badám.	Cultivated; Almora.
	„ „ „	Ladaki ...	„
8	„ (Laurocerasus) Padus [cornuta, Royle].	Jáman ...	Common.
9	„ „ nepalensis ...	„	About 6,000 feet.
10	„ „ undulata [capricida, Wall].	„	„
11	Prinsepia utilis	Bekla, jhatila,	Very common.
	TRIBE SPIRÆEÆ.		
12	Spiræa (Ulmaria) vestita [Kamtschatica, Lindley.	...	Above 8,000 feet.
13	„ (Aruncus) aruncus [triternata, Wall].	...	„ 10,000 feet.
14	„ (Sorbaria) sorbifolia [Lindley and Wall.]	Dhaniyáli ...	„ 8,000 „
15	„ (Chamædrys) bella ...	Jhár ...	Common.
16	„ „ canescens [cuneifolia, Wall].	„ ...	„
17	„ „ vaccinifolia ...	...	Rare.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name	Vernacular name.	Note.
	ORDER 46.—ROSACEÆ—(continued).		
	TRIBE RUBEÆ.		
18	**Rubus (Simplicifoliæ) calycinus** [Dalibarda calycina, D.C.]	.	Rare.
19	„ „ acuminatus	Lál hisálu	„
20	„ „ paniculatus [tiliaceus, Wall].	Kálá „	Common.
21	„ „ moluccanus [rugosus, Smith].	Lál „	„ low levels
22	„ „ reticulatus	Kálá „	„ high levels
23	„ „ lanatus [tiliaceus, St. & W.]	„	About 6,000 feet.
24	„ (Digitatæ) alpestris	..	Rare.
25	„ (Trifoliatæ) saxatilis	Lál hisálu	Above 10,000 feet.
26	„ „ nutans	Pingla „ gangur.	Very common at high elevations.
27	„ „ niveus	Lál „	Very common.
...	„ „ *var.* concolor	Pingla „	Common, China hill.
28	„ „ macilentus [asper Royle]	„ „	„
29	„ „ ellipticus [rotundifolius, Wall; Gowry-phul, Roxb. flavus, Don]	Hisálu	March, very common Fruit much eaten in April and May.
30	„ (Pinnatæ) biflorus	Pingla hisálu,	Frequent.
31	„ „ lasiocarpus [rosæflorus, Roxb.]	Kálá „	Very common, Bhábar, and up to 7,500 feet.
32	„ „ foliolosus	Safed „	Frequent
...	„ „ rosæfolius	Lál „	...
	TRIBE POTENTILLEÆ.		
33	Geum (Eugeum) urbanum	.	Rare.
34	„ (Sieversia) elatum [Potentilla adnata, Wall]	..	Common, above 8,000 feet.
35	Fragaria (Duchesnea) indica	Kaphaliya	„ up to 8,000 feet.
36	„ (Eufragaria) vesca [nubicola, Wall]	...	„ above 7,000 feet.
37	Potentilla (Sibbaldia) Sibbaldi	.	„ Dakuri, at 10,000 feet
38	„ „ axilliflora	.	Rare.
39	„ (Trichothalamus) fruticosa	.	Above 12,000 feet.
40	„ „ ambigua		Colonel Davidson.
41	„ „ eriocarpa	..	Above 12,000 feet.
42	„ (Eupotentilla) Mooniana [polyphylla, Wall]		High elevations.
43	„ „ fulgens [splendens, Wall]	.	Common
44	„ „ Leschenaultiana.		
45	„ „ fragarioides		Very common
46	„ „ peduncularis		Rare. Malári.
47	„ „ leuconota	.	Rare, high levels
48	„ „ microphylla	..	„

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 46.—ROSACEÆ—(continued).		
	TRIBE POTENTILLEÆ—(concluded)		
49	Potentilla (Eupotentilla) multifida ...	...	Rare, Niti pass, 16,000 feet.
50	„ „ sericea ..	...	Rare, high elevations
51	„ „ nepalensis ...	...	Common.
52	„ „ argyrophylla ...	...	Rare.
...	„ „ *var.* atrosanguinea.	...	Common.
53	„ „ nivea ...	...	Rare, high elevations.
54	„ „ Kleiniana ...	...	Common.
55	„ „ supina ...	...	„
	TRIBE POTERIEÆ.		
56	Agrimonia Eupatorium ...	...	Common, June, July.
	TRIBE ROSEÆ.		
57	Rosa (Eleutherostylae) macrophylla.	...	Frequent; China and Binsar.
58	„ „ Webbiana ...	...	Above 8,000 feet, common.
59	„ „ sericea [tetrapetala, Royle.]	...	„ „
60	„ (Systylae) moschata [Brunonis, Wall].	...	Very common; May-June.
	TRIBE POMEÆ.		
61	Cydonia vulgaris	Bihi ...	Cultivated up to 5,000 feet.
62	Eriobotrya japonica	Loquat ...	„ Bhábar.
63	Pyrus (Malus) malus	Seb ...	„ and perhaps wild
64	„ „ baccata	Ban mehal ...	Common; sometimes cultivated.
65	„ (Eupyrus) communis ...	Nashpáti ...	Cultivated.
66	„ „ Pashia [variolosa, Wall].	Mehal ...	Very common.
67	„ „ kumaoni ...	„ ...	Common.
68	„ (Aria) lanata	Galion ...	Above 8,000 feet, common.
69	„ „ vestita	Mauli ...	Common.
70	„ (Sorbus) Aucuparia ...	...	Above 12,000 feet.
71	„ „ foliolosa [ursina, Wall].	Salia halia ...	„ 8,000 feet, very common
72	Stranvæsia glaucescens [Photinia dubia, Madden].	Garmehal, sund.	Very common about 5,000 feet.
73	Cratægus Oxyacandtha	...	Cultivated; rare.
74	„ crenulata	Gingáru ...	Very common.
75	Cotoneaster (Planifolia) bacillaris ...	Raus, rois ...	Common. Walking sticks made of the wood.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 46.—ROSACEÆ—(concluded).		
	TRIBE POMEÆ (concluded).		
76	Cotoneaster (Planifolia) acuminata ...	Rans, rois ..	Common. Walking sticks made of the wood
77	„ „ multiflora ...	...	Rare ; Niti pass.
78	„ „ nummularia ...	...	Colonel Davidson.
79	„ (Recurvifolia) microphylla.	Garí ...	Very common everywhere.
80	„ „ thymifolia ...	„ ...	Common.
81	„ „ buxifolia ...	„ ...	„
	ORDER 47.—SAXIFRAGACEÆ.		
	TRIBE SAXIFRAGEÆ.		
1	Astilbe rivularis [Spiræa barbata, Wall.],	...	Common.
2	Saxifraga (Nephrophyllum) odontophylla.	...	Above 10,000 feet.
3	„ (Hirculus) palpebrata ...	...	Rare ; found near Rálam at 13,000 feet.
4	„ „ saginoides ...	...	„ „
5	„ „ diversifolia ...	...	„ 10,000 „
6	„ (Boraphila) micrantha ...	...	„ 10,000 „
7	„ (Microphylla) imbricata	...	„ 12,000 „
8	„ (Spinulosæ) brachypoda...	...	„ 10,000 „
9	„ „ fimbriata ...	...	„ 11,000 „
10	„ „ filicaulis ...	...	„ 10,000 „ Pindari.
11	„ (Flagellares) Brunoniana,	...	China peak.
12	„ (Bergenia ligulata ...	Silphora ...	March ; very common.
...	„ „ var. ciliata, Royle	„ ...	Very common.
13	Chrysosplenium (Oppositifolia) nepalense.	...	Common.
...	„ „ var. sulcatum,	...	„
14	„ „ trichospermum,	...	„
15	„ (Alternifolia) tenellum ...	...	Near Kedár Kánta.
16	Parnassia nubicola	...	Common.
	TRIBE HYDRANGEÆ.		
17	Hydrangea (Truncatæ) altissima ...	...	Frequent.
18	„ „ aspera ...	Bhújhata ...	„
19	„ „ (Coronatæ) vestita.	„ ...	„
20	Deutzia corymbosa	...	May, common, high elevations.
21	„ staminea	...	May, very common.
22	„ macrantha	...	May, rare.
23	Philadelphus coronarius, *var.* tomentosus.	Bukyal, dhaniyali.	June, frequent at high elevations. Wán.
	TRIBE ESCALLONIEÆ.		
24	Itea nutans	Garkath ...	Common at low elevations.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 47.—SAXIFRAGACEÆ—(concluded).		
	TRIBE RIBESIEÆ.		
25	Ribes (Grossularia) grossularia ...	...	Common about 10,000 feet.
26	„ (Ribesia) glaciale [acuminatum, Wall].	Kokaliya ...	„ above 10,000 feet.
27	„ „ nigrum	Páphar ...	„ about 10,000 feet.
28	„ „ rubrum	„ ...	„ „
	ORDER 48.—CRASSULACEÆ.		
	TRIBE ISOSTEMONES.		
1	Tillæa pentandra	...	Common.
2	Crassula indica	...	Frequent, Gágar.
3	Cotyledon oreades	...	Above 13,000 feet.
	TRIBE *DIPLOSTEMONES OPPOSITIFOLIA*.		
4	Bryophyllum calycinum	...	Bhábar ; introduced.
5	Kalanchoe spathulata [varians, Wall],	Bakal patta,	Very common. Goats poisoned by eating this plant.
	TRIBE DIPLOSTEMONES ALTERNIFOLIA.		
6	Sedum (Rhodiola) Rhodiola [rosea, Linn].	...	Common above 12,000 feet.
7	„ „ crenulatum ...	...	Frequent above 12,000 feet.
8	„ „ quadrifidum ...	...	Common above 12,000 feet.
9	„ „ asiaticum ...	...	„ above 11,000 feet.
10	„ „ linearifolium ...	...	„ on trees.
11	„ „ trifidum [sinuatum, Royle]	...	„ „ September.
12	„ (Eusedum) rosulatum ...	...	Common, April May.
13	Sedum [Eusedum) adenotrichum ...	...	Common, April, and May.
14	„ „ trullipetalum ...	...	Above 11,000 feet.
15	„ „ Ewersii [rubrum... Royle].	...	Frequent.
16	„ „ multicaule ...	...	Common, July.
17	Sempervivum mucronatum ...	...	Above 10,000 feet.
18	„ sedoides	...	„ 10,000 feet.
	ORDER 49.—DROSERACEÆ.		
1	Drosera Burmanni	...	Bhábar.
2	„ peltata	...	Very common.
	ORDER 50.—HALORAGEÆ.		
1	Myriophyllum spicatum	..	Naini Tál lake.
2	Callitriche verna	...	„

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 51.—COMBRETACEÆ.		
	TRIBE COMBRETEÆ		
1	Terminalia (Catappa) belerica ...	Behara ...	Frequent; Ganai, March.
2	„ „ Chebula ...	Har, harira,	Common up to 5,000 feet, April, May.
3	„ (Pentaptera) Arjuna [glabra, Roxb].	Sáj ...	Bhábar, April, May.
4	„ „ tomentosa ...	„ ...	Common up to 4,000 feet, April.
5	Anogeissus latifolius	Bákla ...	„ outer range.
6	Combretum (Poivrea) decandrum ...	...	„ Feb., March.
7	„ (Eucombretum) nanum...	Pharsiya ...	Bhábar; very common, March, April.
8	Quisqualis indica	...	„ gardens.
	ORDER 52.—MYRTACEÆ.		
	TRIBE LEPTOSPERMEÆ.		
1	Eucalyptus obliqua	Stringy bark	Introduced.
2	„ globulus	Blue gum ...	„
	TRIBE MYRTEÆ.		
3	Psidium Guyava	Amrúd ...	Introduced.
4	Myrtus communis	Wiláyati mendhi.	Cultivated, up to 8,000 feet.
5	Eugenia (Jambosa) Jambos ...	Guláb jáman,	Cultivated; Bhábar.
6	„ (Syzygium) operculata ...	Rái „	Bhábar.
7	„ „ Jambolana ...	Jáman.	„ and valleys.
	TRIBE BARRINGTONIEÆ.		
8	Barringtonia acutangula ...	...	Banks of streams; Bhábar.
9	Careya herbacea	...	Bhábar, March.
10	„ arborea	Kumbh ...	„ „
	ORDER 53.—MELASTOMACEÆ.		
1	Osbeckia chinensis [angustifolia, Don].	Kukar-makri,	Frequent, autumn.
2	„ stellata	„ „	Common „
	ORDER 54.—LYTHRACEÆ.		
	TRIBE AMMANNIEÆ.		
1	Ammannia (Rotala) peploides ...	...	Rare. In damp places.
2	„ „ rotundifolia ...	Darmiya ...	Very common „
3	„ (Euammannia) salicifolia,	...	Bhábar swamps, and up to 4,000 feet.
4	„ „ senegalensis,	...	Frequent up to 5,000 feet.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 54.—LYTHRACEÆ (concluded).		
	TRIBE LYTHREÆ.		
5	Woodfordia floribunda [Grislea tomentosa, Roxb.]	Dhai ...	Very common, April.
6	Lawsonia alba	Mendhi ...	Common gardens.
7	Lagerstrœmia (Velaga) indica ...	Gulbahár ...	August, common, gardens.
8	„ „ parviflora ...	Dhaura ...	Very common, Bhábar.
9	„ (Adambea) Flos-Reginæ,	Járal ...	Rare. Gardens.
10	Punica Granatum	Dárim ...	Very common up to 5,000 feet.
	ORDER 55.—ONAGRACEÆ.		
	SECTION POLYSPERMEÆ.		
1	Epilobium (Chamænerium) angustifolium.	...	Frequent.
2	„ „ latifolium ..	...	High elevations.
3	„ (*Lysimachion*) *hirsutum*,	...	Common.
4	„ „ roseum ...	...	Bhim Tál.
5	„ „ tetragonum...	...	Naini Tál.
6	„ „ laxum, Royle,	...	
7	Acnothera rosea	..	Naturalized.
8	„ nocturna	...	„
9	„ grandiflora	...	„
	SECTION OLIGOSPERMA.		
10	Circæa lutetiana [repens, Wall] ...	...	Common.
	„ alpina [intermedia, Wall] ...	...	„
	ORDER 56.—SAMYDACEÆ.		
1	Casearia graveolens	Chila, chilra.	Fruit used to poison fish.
	„ tomentosa	„ „	„ „
	ORDER 57.—PASSIFLORACEÆ.		
1	Passiflora, species	...	Cultivated.
	ORDER 58.—CUCURBITACEÆ.		
	SECTION SIGMATOPERÆ.		
1	Trichosanthes palmata	Indráyan ...	Common.
2	„ cucumerina ...	...	Bhábar.
3	„ anguina	Chichinda ...	Cultivated.
4	Herpetospermum caudigerum ...	...	Rare.
5	Lagenaria vulgaris	Lauka, lauki, tumri.	Cultivated.
6	Luffa ægyptiaca [pentandra, Roxb.]	Ghia torai ...	„
7	„ acutangula [triandra] ...	Torai ...	„
8	Benincasa cerifera	Bhuja, petha, kumhra.	„
9	Momordica Charantia	Karela ...	„

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 58.—CUCURBITACEÆ—(concluded).		
	SECTION SIGMATOSPERMÆ—(concluded).		
10	Momordica dioica	...	Frequent.
11	Cucumis trigonus	Airálu ...	Common.
12	,, Melo [utillissimus, Roxb.]...	Kakri ...	Cultivated.
13	,, sativus	Kakri, khíra,	,,
14	Citrullus Colocynthis	Tarbuza ...	Wild and cultivated.
15	,, vulgaris	,, ...	Cultivated.
16	Cephalandra indica [Coccinia indica, W. and A.].	Kunderu ...	Bhábar.
17	Cucurbita maxima	Kadu ...	Cultivated.
	SECTION ORTHOSPERMÆ.		
18	Bryonia laciniosa	...	Common.
19	Mukia scabrella	...	,,
20	Zehneria umbellata	Gwála-kakri,	,,
	,, *var.* nepalensis ...	...	,,
21	Melothria odorata	...	Rare.
22	Edgaria darjeelingensis	...	,,
23	Gynostemma pedata	...	,,
	ORDER 59.—BEGONIACEÆ.		
1	Begonia (Knesebeckia) picta ...	...	Common, autumn.
2	,, (Trilobaria) amœna [tenella, Don.].	...	,, ,,
	ORDER 60.—DATISCACEÆ.		
1	Datisca Cannabina	Bhang-jala...	Common.
	ORDER 61.—CACTACEÆ.		
1	Opuntia Dillenii	Nág-phansa,	Introduced. Common up to 6,000 feet.
	ORDER 62.—FICOIDEÆ.		
1	Trianthema crystallina ...	...	Bhábar.
2	,, pentandra ...	...	,,
3	Mollugo stricta	...	Common.
	ORDER 63.—UMBELLIFERÆ.		
	SECTION HETEROSCIADIÆ.		
1	Hydrocotyle javanica	...	Common.
2	,, rotundifolia ...	...	Rare.
3	,, asiatica	...	Bhábar.
4	Sanicula europæa [elata, Don.] ...	...	Common, June, Bánj-bagr.

DIVISION I.—POLYPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 63.—UMBELLIFERÆ—(concluded).		
	SECTION HAPLOZYGIÆ.		
	TRIBE AMMINEÆ.		
5	Vicatia coniifolia	...	Kháti Pindari, May.
6	„ Stewartii	...	Rare, Garhwál.
7	Bupleurum lanceolatum ...	...	Common, June, Bánj lagr.
8	„ Candollii	...	Above 8,000 feet.
9	„ diversifolium ...	...	„ 7,000 „
10	„ falcatum, *var.* marginata,	...	Naini Tál, common.
11	„ longicaule	...	Above 8,000 feet.
12	„ tenue	...	Common.
13	Carum (Glabræ) Carui	...	Rare.
14	„ (Hispidæ) Roxburghianum ...	...	Cultivated.
15	„ „ anethifolium ...	...	Almora, common.
16	Pimpinella (Glabræ) achilleifolia ...	...	Common.
17	„ [Reutera, Edgw.] acuminata.	...	Naini Tál, common.
18	„ [Acronema, Edgw.] tenera...	...	Naini Tál, on oaks, common.
19	„ (Papillosæ diversifolia trifoliata, Wall.	Dhanjari ...	Very common.
20	„ „ Stracheyi ...	...	Rare; banks of Dhauli.
21	„ „ cæspitosa ...	...	„ „
22	Osmorrhiza Claytoni [laxa, Royle] ...	...	Frequent.
23	Chærophyllum villosum	...	„
	„ reflexum	...	Rare.
	TRIBE SESELINEÆ.		
24	Seseli trilobum	...	Rare; Niti and Milam.
25	Fœniculum vulgare [panmorium, Roxb.]	Sonf ...	Cultivated.
26	Ænanthe stolonifera	...	Low elevations, common.
27	Ligusticum marginatum ...	...	Naini Tál, common.
28	„ elatum [Cortia elata, Edgw.]	...	„ „
29	Selinum tenuifolium [Selinum Candollii, Edgw.]	...	Common.
30	„ vaginatum [Cortia vaginata, Edgw.]	...	Frequent.
31	Cortia Lendeii	...	„
32	Pleurospermum [Hymenolæna, D. C.] Govanianum.	...	High elevations.
33	„ „ Candollii.	...	„
34	„ angelicoides „	...	Rare; Bálam river, 11,500 feet.
35	„ dentatum „	...	Frequent.
36	„ stellatum „	...	Rare; Milam glacier.
37	„ densiflorum „	...	High elevations.

DIVISION I.—POLYPETALÆ—(*concluded*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 63.—UMBELLIFERÆ—(concluded).		
	SECTION HAPLOZYGIÆ—(concluded).		
	TRIBE PEUCEDANEÆ.		
38	Peucedanum graveolens [Anethum sowa, Roxb.]	Soa ...	Cultivated.
39	" Dhana	...	Up to 4,000 feet.
40	Heracleum Brunonis	...	Rare.
41	" candicans	...	Common.
42	" nepalense	...	Frequent.
	SECTION DIPLOZYGIÆ.		
43	Coriandrum sativum	Dhaniya ...	Cultivated.
44	Daucus Carota	...	"
45	Caucalis Anthriscus	...	Very common.
	ORDER 64.—ARALIACEÆ.		
	SECTION IMBRICATÆ.		
1	Aralia cissifolia	...	Rare.
2	" cachemirica [Panax tripinnatum, Wall.]	...	Pindari, autumn.
3	Pentapanax parasiticum ...	Kot semal ...	Up to 7,000 feet.
4	" Leschenaultii, *var.* umbellatum [Hedera fragrans, Don.] [Panax bijugum, Wall.]	...	"
	SECTION VALVATÆ.		
5	Heptapleurum impressum [tomentosum, Don.]	...	Common.
6	" elatum	...	Rare.
7	" venulosum [Hedera terebinthacea, Wall.]	...	Up to 3,000 feet.
8	Heteropanax fragrans [Panax fragrans, Roxb.]	...	Low elevations, November.
9	Hedera helix, *var.* æsculifolia ...	Bánda ...	Very common.
	ORDER 65.—CORNACEÆ.		
1	Alangium Lamarckii [hexapetalum, Roxd., decapetalum, Wight].	...	Bhábar, rare. March.
2	Marlea bigoniæfolia	Tumri ...	Bageswar, May.
3	Cornus macrophylla	Kágshi ...	Common, May.
4	" oblonga	...	Frequent, September.
5	" nervosa, Royle ...	...	Rare.
6	" capitata [Benthamia fragifera],	Bamaura ...	Common. Fruit edible, summer.

DIVISION II.—MONOPETALÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—CAPRIFOLIACEÆ.		
	TRIBE SAMBUCEÆ.		
1	Viburnum cotinifolium, Don. ...	Gwiya ...	Very common, June
2	„ Mullaha, Don [stellulatum, Wall.].	Lál titmuliya,	Common, July.
3	„ cylindricum, Don. [coriaceum, Blume.].	Kála titmuliya,	„ January.
4	„ punctatum, Don. [acuminatum, Wall.].	...	Common, Binsar, July.
5	(Triloculares) nervosum, Don. [grandiflorum, Wall.].	...	„ Upper Sárju.
6	„ erubescens, Wall.] ...	...	Common, April-June.
	TRIBE LONICEREÆ.		
7	Triostium himalayanum ...	Dur-bank ...	Above 8,000 feet.
8	Abelia triflora	Munri ...	Common, June.
9	Lonicera diversifolia, Wall. [L. quinquelocularis, Hard.].	Bhat-kukri,	„ June and July.
10	Lonicera orientalis [Govaniana] ...	...	Rare; Bhatkot. June.
11	„ alpigena [Webbiana, Wall.] ..	...	Rare; Pindari, June.
12	Leycesteria formosa [Lonicera quinquelocularis, Hard.].	Nalkaru, karnaliya.	Common. Confused by Hardwicke with No. 10.
	ORDER 2.—RUBIACEÆ.		
	TRIBE NAUCLEÆ.		
1	Anthocephalus (Nauclea) Cadamba,	Kadam ...	Cultivated, June.
2	Adina (Nauclea) cordifolia ...	Haldu ...	Common; Haldwáni, July.
3	Stephagyne (Nauclea) parvifolia ...	Phaldu ...	„ Bhábar, June.
	TRIBE CINCHONACEÆ.		
4	Hymenopogon parasiticus ...	Bhainalya-padera.	On oaks at Binsar.
5	Hymenodictyon excelsum ...	Bhalena ...	Common, June.
6	„ flaccidum ...	...	Rare, June.
7	Wendlandia exserta [W. cinerea Rondeletia exserta].	Chilkiya ...	Common, March.
8	„ tinctoria ...	...	Bhábar, February.
	TRIBE HEDYOTIDEÆ.		
9	Argostemma sarmentosum ...	...	Frequent.
10	Hedyotis Lindleyana	...	Common.
11	„ calycina	...	„
12	Oldenlandia Burmanniana ...	...	„
13	„ (Kohautia) coccinea ...	...	„
14	„ gracilis	...	„
15	„ stipulata	...	Rare.
16	Ophiorhiza nana	...	„
17	„ Mangus	...	„
18	„ bracteolata	...	„

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 2.—RUBIACEÆ—(concluded).		
	TRIBE GARDENIÆ.		
19	Gardenia turgida [longispina, Madden.].	Thanela ...	Bhábar.
20	„ latifolia	Pindálu ...	„
21	Randia tetrasperma	Bhotiya gingáru and Bara gari.	Very common.
22			
23	„ dumetorum	Mainphal ...	Bhábar.
	„ uliginosa	Pindálu. ...	„
	TRIBE KNOXIÆ.		
24	Knoxia mollis	...	Frequent.
	TRIBE IXORIÆ.		
25	Pavetta tomentosa [Ixora tomentosa, Roxb.].	Padera ...	Common.
26	Coffea bengalensis, ...	Kath jahi . .	Frequent, March.
	TRIBE PÆDERIÆ.		
27	Hamiltonia scabra, Dec. [suaveolens, *var.* azurea, Wall.]	Jogiya-padera,	Common, November.
28	Leptodermis lanceolata	Padera ...	Very common, summer.
	TRIBE SPERMACOCEÆ.		
29	Spermacoce articularis	...	Common.
30	„ lasiocarpa [stricta, Roxb]	...	„
	TRIBE GALIACEÆ.		
31	Rubia cordifolia	Májethi	Common.
32	„ nervosa, Edge.	... ...	Rare; Gangoli bridge.
33	„ Munjista	...	Rare.
34	„ alata	...	„
35	Galium asperifolium	Kuri ...	Common.
36	„ elegans	„ ...	„
37	„ Hamiltonii [G. latifolium, Don.]	„ ...	Frequent.
38	„ hirtiflorum [G. ciliatum, Don.]	„ ...	„ Binsar.
39	„ aparine.	„ ..	Introduced.
40	asperuloides, Edge., [tricorne, Dr. King.]	„ .	Very common; above 10,000 feet.
	ORDER 3.—VALERIANEÆ.		
1	Nardostachys grandiflora ...	...	Rare.
2	Valeriana Wallichii	Shami ...	Frequent.
3	„ Hardwickii [V. elata, Don.]	„ ...	Common.
4	„ tenera	„ ...	Frequent.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 4.—DIPSACEÆ.		
1	Morina Wallichiana [breviflora, Edge.?]	...	Common.
2	„ longifolia	...	Above 10,000 feet.
3	Dipsacus strictus, Don.	...	China, 8,700 „
4	„ inermis	...	Very common.
5	„ levis?	Narao ...	Common.
6	Scabiosa Candollii	...	„ May.
	ORDER 5.—COMPOSITÆ.		
	TRIBE VERNONIACEÆ.		
1	Vernonia (Stengelia) anthelmintica,	...	Rare; autumn.
2	„ (Tephrodes) cinerea ...	Kálajira ...	Very common up to 8,000 feet.
	„ „ var. montana ...	„ ...	Common.
3	„ (Xipholepis) teres ...	...	Col. Davidson.
	TRIBE EUPATORIÆ.		
4	Adenostemma viscosum, *var.* latifolium	...	Common up to 2,500 feet.
5	Ageratum conyzoides	...	Autumn, common up to 6,000 feet.
6	Eupatorium longicaule	...	October, common.
	TRIBE ASTEROIDEÆ.		
7	Solidago virga aurea [Amphiraphis pubescens, D. C.]	...	Summer, common.
8	Dichrocephala latifolia	...	„
9	Cyathocline lyrata	...	Common up to 4,000 feet.
10	Myriactis nepalensis [oleosa, Edgw.]	...	Autumn, common.
11	„ Wallichii [gracilis, Edgw.]	...	„
12	„ Gmelini	...	October, frequent.
13	Rhynchospermum verticillatum ...	...	Autumn; rare.
14	Callistephus chinensis	Naipala ...	Introduced.
15	Aster (Euaster) amellus	...	Aug., above 8,000 feet.
16	„ (Alpigenia) alpinus ...	...	July, above 11,000 feet.
17	„ (Orthomeris) molliusculus ...	...	May and June; frequent.
18	„ „ altaicus ...	...	Aug., above 9,000 feet.
19	„ „ spartioides ...	...	„
20	„ (Calimeris) peduncularis ...	...	September, October; common.
21	Erigeron canadense	Sallo ...	Introduced, but now very common.
22	„ acre [Roylei, D. C.] ...	Mirch múl ...	May, August; very common.
23	„ multiradiatum ...	...	July, August; rare.
24	Microglossa cabulica [Aster ferrugineus, Edgw.].	...	Rare; Badrináth.
25	Conyza veronicæfolia	...	September, common.
26	„ viscidula [polycephala, Edgw.],	...	Feb., up to 4,000 feet.
27	„ absinthifolia	...	Very common, autumn.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 5.—COMPOSITÆ—(continued).		
	TRIBE INULOIDEÆ.		
28	Blumea Wightiana	...	Spring; Bhábar.
29	„ lacera	...	„ very common.
30	„ hieracifolia	...	May, common.
31	„ runcinata [laciniata, Roxb.],	...	frequent.
32	„ oxydonta	...	„
33	Blumea densiflora	...	November; Col. Davidson.
34	Laggera alata	Amdok ...	October; common.
35	Sphæranthus hirtus [mollis, Roxb.],	...	Spring; „
36	Filago arvensis, *var.* lutescens ...	...	Common.
37	Leontopodium alpinum	...	Above 12,000 feet.
38	Anaphalis cinnamonea	Jhula, bokla,	Autumn; common.
39	„ triplinervis	...	„ „
40	„ nubigena	...	„ above 9,000 feet.
41	„ mucronata	...	„ above 12,000 feet.
42	„ tenella [contorta, Don.] ...	...	„ very common.
43	„ margaritacea	...	„ Col Davidson.
44	„ adnata	...	„ common.
45	„ araneosa	...	„ „
	var. semidecurrens ...	...	„ very common.
46	Phagnalon niveum	...	June; banks of Dhauli near Niti pass.
47	Gnaphalium hypoleucum ...	...	Autumn; very common.
48	„ luteo album ...	...	„ common.
49	Cæsulia axillaris	...	October; rice fields; Ganai.
50	Inula [Corvisartia] Royleana ...	...	Above 10,000 feet.
51	„ (Bubonium) vestita ...	...	Spring; up to 3,000 feet.
52	„ nervosa [nitida, Edgw.] ...	...	Autumn; frequent.
53	„ barbata	...	„ „
54	„ (Cappa) Cappa	Tamagari ...	November; very common.
55	„ cuspidata	...	October; common.
56	„ rubicaulis	...	March; frequent.
57	Vicoa indica	...	Common.
58	Carpesium cernuum *var.* nepalense ...	...	Autumn; common.
	„ *var.* pedunculosum,	...	
	„ *var.* trachelifolium,	...	
59	„ abrotanoides [racemosum, Wall].	...	Autumn; rare.
	TRIBE HELIANTHOIDEÆ.		
60	Adenocaulon himalaicum ...	...	September; rare.
61	Xanthium strumarium	...	Up to 5,000 feet.
62	Zinnia elegans	...	Naturalized.
63	„ multiflora	...	„
64	Seigesbeckia orientalis	Gobariya ...	October; very com-

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 6.—COMPOSITÆ—(continued).		
	TRIBE HELIANTHOIDEÆ—(concluded).		
65	Eclipta alba, *var.* erecta	...	Common.
	„ „ prostrata ...	...	„
66	Blainvillea latifolia	Karshaniya...	Very common.
67	Wedelia biflora ?	...	Rare.
68	Coreopsis (Calliopsis) tinctoria ...	...	Naturalized.
69	Bidens (Platycarpæa) tripartita [repens, Don.]	...	June, October ; common.
70	„ (Pallocarpæa pilosa ..	...	Very common.
71	„ „ decomposita,	...	„
72	Glossogyne pinnatifida ...	...	Low elevations.
73	Chrysanthellum indicum ...	...	September; introduced.
74	Galinsoga parviflora	...	„
	TRIBE HELENIOIDEÆ.		
75	Tagetes patula	...	Gardens and naturalized.
76	„ erecta	...	„
	TRIBE ANTHEMIDEÆ.		
77	Achillea millefolium, *var.* cuspidata, Wall.	...	Rare.
78	Allardia tridactylites ? ...	...	Above 15,000 feet.
79	„ tomentosa	...	Above 12,000 feet.
80	Cotula anthemoides ?	...	February ; rare.
81	Tanacetum longifolium	...	September, about 11,000 feet.
82	Artemisia (Dracunculus) scoparia ...	Jhao ...	October, common.
83	„ „ parviflora...	...	„
84	„ (Abrotanum) vestita ...	Deo pati ...	September, October ; rare ; Jagcawar.
85	„ „ vulgaris [indica, Roxb.]	Pati ...	September, October ; very common.
	„ „ *var.* hypoleuca, Edgw.	...	Common.
86	„ (Absinthium) sieversiana,	...	About 12,000 feet ; Jhelam.
	TRIBE SENECIONIDÆ.		
87	Tussilago farfara	...	Common; banks of streams above 10,000 feet.
88	Doronicum Roylei [Fullartonia Kumaonensis, D.C.]	...	High elevations.
89	Gynura nepalensis, *var.* Thomsoni ...	...	March, common, Ránibagh.
90	Emilia sonchifolia	...	Very common.
91	Senecio (Synotis) alatus... ...	...	October, November ; Pindari, China hill.
92	„ „ densiflorus ...	...	October to April; very common.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 5.—COMPOSITÆ—(continued).		
	TRIBE SENECIONIDEÆ—(concluded).		
93	Senecio (Synotis) rufinervis ...	...	November, frequent.
94	„ „ Kunthianus ...	...	September, above 10,000 feet
95	„ „ Candolleanus ...	...	„ „
96	„ (Eusenecio) graciliflorus, ..	...	October, high levels.
97	„ „ chrysanthemoides,	...	„ Pindari.
98	„ „ pallens [violaceus, Wall].	Rat patiya ...	March, June, very common.
99	„ (Ligularia) sibiricus ...	...	September, Pindari.
100	„ „ arnicoides ...	...	„ „
101	„ Cacalia) quinquelobus .	...	Above 10,000 feet.
	TRIBE CYNAROIDEÆ.		
102	Echinops niveus	Kanaila, jaokanda.	Very common.
103	Carduus nutans	...	Above 8,000 feet, Jhelam near Niti.
104	Cnicus arvensis	...	Rare.
105	„ eriophorus *var.* involucratus,	...	Autumn, common.
106	„ ferox, Edgw.	...	May common.
107	„ argyracanthus	...	June common.
108	„ *var.* nepalensis	...	October, common.
109	„ Wallichii (arachnoidea, Wall),	...	„ „
110	Saussurea (Bracteatæ) obvallata .	...	September, above 10,000 feet.
111	„ (Acaules) Kunthiana ...	...	„ „
112	„ (Congestæ) gossypina (sacra, Edgw).	Kanwal ...	September, common above 10,000 feet.
113	„ „ grammifolia ...	...	„ about 10,000 feet.
114	„ (Coarctatæ pterocaulon ...	...	„ about 10,000 feet.
115	„ (Corymbosæ) candicans ...	...	Very common.
116	„ „ *var.* scaposa.	...	Common, April, Panwa Naula.
117	„ „ albescens ...	...	September, frequent.
181	„ „ denticulata,	...	September, common.
119	„ „ hypoleuca ...	...	„ „
120	Jurinea macrocephala (Dolomiæa macrocephala, D. C.).	Kálá tagar ...	„ „ Pindari.
121	Serratula pallida	...	May, June, very common.
122	Tricholepis furcata	...	November, Pindari.
123	„ elongata	...	October, common.
124	Volutarella divaricata	...	March, Haldwáni.
125	Carthamus tinctorius	Kusam ...	„ Cultivated, Bhábar.
	TRIBE MUTISIACEÆ		
	SECTION SUBÆQUALIFLORÆ.		
126	Leucomeris spectabilis	...	May, common.
127	Ainsliæa pteropoda	...	Spring, very common.
	„ aptera	...	„ „

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 5.—COMPOSITÆ—(concluded).		
	SECTION LABIATÆFLORÆ.		
128	Gerbera lanuginosa (Chaptalia gossypina, Royle)	...	June, high elevations.
129	„ nivea	...	September „
130	„ macrophylla (Chaptalia maxima, Don).	...	„ „
	TRIBE CICHORACEÆ.		
131	Cichorium intybus	...	Cultivated.
132	Picris hieracioides	...	Maipat near Lohághát, October.
132	Crepis (Barkhausia) fœtida ...	...	May, June, very common.
133	„ (Youngia) lyrata [runcinata Wall].	...	Very common. An Lactuca ?
134	Taraxacum Dens leonis ...	...	Very common.
...	„ *var.* eriopodium .	...	„ „
...	„ *var.* parvulum ...	...	High elevations.
135	Lactuca (Brachy ramphus) obtusa . .	Jangli gobhi,	April, May, very common ; yellow.
...	„ [Microrhynchus nudicaulis and patens, D.C]	...	
136	„ (Scariola) scariola .	...	Low elevations ; yellow.
...	„ „ *var.* sativa ...	...	Cultivated „
137	„ (Cicerbita) auriculata ..	...	May, July, very common ; blue.
138	„ „ longifolia ...	...	October, fields, common ; blue.
139	„ (Lactucopsis sagittarioides,	...	February, common ; blue. An Crepis ?
140	„ „ Brunoniana [Prenanthes Brunoniana, D.C]	...	August, October, common ; blue.
141	„ (Melanoseris) hastata ...	...	Autumn, common; Lohba ; blue or white.
142	„ „ lævigata [macrorhizon, Royle.]	...	September, very common ; blue.
143	„ „ violæfolia ...	...	September, high elevations ; blue.
144	„ „ Lessertiana ...	...	Common, October ; blue.
145	„ „ dubyæa [Dubyæa hispida, D.C.]	...	September. very common ; yellow.
146	„ (Ixeris) glabra ...	...	Winter, low elevations ; yellow.
147	„ „ polycephala ...	...	„ „
148	Prenanthes hispidula	...	Rare.
149	Sonchus asper	Ufat kancla nalsha.	Spring, very common.
150	„ oleraceus	„	Spring, common, edible.
151	„ arvensis	„	Spring, common.
152	Michrorhynchus secundus ...	...	Rare ; Royle.
153	Tragopogon junceum	...	June, July, very common.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 6.—LOBELIACEÆ.		
1	**Lobelia** trigona, Roxb., [trialata, Don.]	...	Common.
2	„ pyramidalis, Wall ...	...	Frequent.
3	„ rosea, Wall	...	Rare; Malwa Tál.
	ORDER 7.—CAMPANULACEÆ.		
1	Cephalostigma hirsuta	Gol ghanna,	Frequent.
2	Wahlenbergia viridis, Edgw. ...	...	Wácham, near Pindari.
3	„ agrestis	...	Frequent, Banks of Kosi.
4	Campanula latifolia	...	Rare.
5	„ sylvatica [integerrima Don].	...	Common under trees.
6	„ canescens	..	Very common.
7	„ argyrotricha [pallida, Madden].	.	„
8	„ colorata ramulosa, Wall]	...	Rare.
	ORDER 8.— ERICACEÆ.		
1	Gualtheria nummularia	Bhalu bor ...	Common, Dákuri, Bhatkot.
2	„ trichophylla	...	Frequent, above 10,000 feet.
3	Andromeda (Pieris) ovalifolia, [A. capricida,' Don.]	Aiyár ...	Very common.
4	„ (Cassiope fastigiata [A cupressiformis, Wall.]	Kambu ..	Milam and Pindari, 12,000 feet.
5	Rhododendron arboreum .. .	Buráns ..	Very common.
..	„ *var.* roseum .	..	Above 8,000 feet.
6	„ campanulatum	Chimul .	„ 10,000 „
7	„ anthopogon .	Talisfár .	„ 12,000 „
8	„ lepidotum	...	„ 12,000 „
	ORDER MONOTROHEÆ.		
1	Monotropa nepalensis	Chháo ..	Binsar, September; found by Mrs. Govan.
	ORDER 10.—LENTIBULARIÆ.		
1	Utricularia flexuosa [stellaris, ... Wight].	...	Common.
2	Pinguicula alpina	...	Rare.
	ORDER 11.—PRIMULACEÆ.		
1	Primula (Sphondylia) floribunda ...	...	Down to 2,500 feet.
2	„ (Primulastrum) petiolaris [nana, Wall].	...	Above to 10,000 feet.
3	„ (Athritica) purpurea ...	...	„

DIVISION II.—MONOPETALÆ—(*continued*)

No.	Scientific name.	Vernacular name.	Note.
	ORDER 11.—PRIMULACEÆ—(concluded).		
4	Primula Stuartii ...	...	...
5	,, (Aleuritia) speciosa ...	Bish kopra...	Common.
6	,, involucrata	...	Above 10,000 feet
7	,, denticulata, *var.* erosa ..	...	Common, high elevations.
8	Androsace sarmentosa, Wall ...	...	,,
9	,, lanuginosa, Wall ..		Above 12,000 feet.
10	,, rotundifolia, *Hardw.* ...	. .	Common.
11	,, incisa Wall, [rotundifolia, Don].	...	Valleys and Bhábar winter and spring.
12	Lysimachia (Ephemerum) lobelioides,	. .	Very common above 10,000 feet.
13	,, pyramidalis	...	Common.
14	,, (Lysimastrum) alternifolia .	...	,,
15	,, debilis	...	,,
16	Anagallis arvensis, *var.* cœrulea ...	Jonk-mara ...	,,
17	Samolus Valerandii	...	Rare, Suál river.
	ORDER 12.—MYRSINACEÆ.		
1	Mæsa (Bæobotrys) indica ...	Kalsis ...	Common. Low elevations
2	,, argentea	Phusera ...	Frequent, Binsar.
3	Myrsine africana	Pahári chá, baiberang.	Common, March.
4	,, semiserrata	Chupra ...	,,
5	,, acuminata	,, ...	,,
6	Embelia robusta	Baiberang ...	Bhábar.
7	Ardisia floribunda	...	Rare.
	ORDER 13.—SAPOTACEÆ		
1	Bassia butyracea	Chiúrá and phalel.	Common at 4,000 feet, near Petoragarh.
2	,, latifolia	Mahúá ...	Bhábar.
	ORDER 14.—EBENACEÆ.		
1	Diospyros Melanoxylon	Tendu ...	Bhábar.
2	,, montana	Tendu ...	,,
3	,, lanceæfolia . ..	Ardinia . .	Kota Dún
4	,, Embryopteris ...	Gab ...	Bhábar.
	ORDER 15.—SYMPLOCEÆ.		
1	Symplocos (Hopea) sulcata . .	Lodh, bhotya.	Bhábar also, November
2	,, spicata . .	..	Rare, Siáhi devi.
3	,, racemosa		Bhábar, November.
4	,, ramosissima [nervosa, Madden]	...	Rare, Gágar, Binsar. May.
5	,, (Palura) cratægoides [S. paniculata, Madden].	Lodh .	Very common, June and July.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 16. OLEACEÆ.		
1	Fraxinus excelsior	Angu ...	Common.
2	" (Ornus) floribunda ...	Angu ...	Common.
3	Syringa emodi	Chin ..	Common, above 10,000 feet.
4	Olea cuspidata [ferruginea, Royle Ill.]	Kalap briksh,	Patál debi near Almora.
5	" acuminata *var.* longifolia.	Silang ...	Very common, wild and planted.
6	" glandulifera ..	Gair ...	Common.
7	Ligustrum nepalense	...	Banks of streams, May,
8	" bracteatum	...	Frequent, Binsar, June.
9	" robustum	...	Common, May.
10	" compactum	...	"
	ORDER 17.—JASMINEÆ.		
1	Jasminum (Simplicifoliæ) Sambac ..	...	Cultivated.
2	" pubescens	...	Frequent, Ganai.
3	" arborescens	...	" Bhábar.
4	" nepalense [dichotomum, Don].	Jáhi ...	Common.
5	" (trifoliæ) dispermum ...	Surmáli. ...	Common. Leaves, generally trefoil, but sometimes simple and sometimes pinnate.
6	Jasminum (Alternifoliæ) revolutum [chrysanthemum, Roxb.]	Sonajáhi ...	Common.
7	" " pubigerum .	...	Rare.
8	" (Pinnatifoliæ) officinale,	Chambeli ...	Introduced.
9	" " grandiflorum,	Chambeli and jáhi.	Common.
10	Nyctanthes Arbor-tristis ...	Pariját, harsinghár of plains.	
11	Schrebera swietenoides	Moka ...	Bhábar tree
	ORDER 18.—APOCYNACEÆ.		
	TRIBE CARISSEÆ.		
1	Carissa diffusa	Timukiya ...	Bhábar.
	TRIBE PLUMERIEÆ		
2	Tabernæmontana coronaria ...	Chandi ...	"
3	Vinca pusilla [V. parviflora, Roxb.] ..	...	"
	TRIBE PARSONSIEÆ.		
4	Vallaris dichotoma	Dúdhi ..	Common.
	TRIBE WRIGHTIEÆ.		
5	Wrightia mollissima ... - ...	Darhela ...	"

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 18.—APOCYNACEÆ (concluded).		
	TRIBE ALSTONIEÆ.		
6	Alstonia scholaris	...	Bhábar.
7	Blabeapus lucidus	Dúdhi ...	Common.
	TRIBE ECHITEÆ.		
8	Holarrhena antidysenterica ...	Kuer ...	„
9	„ pubescens	...	„
10	Nerium odorum	Kanyár ...	
11	Chonemorpha macrophylla, [Echites macrophylla, Roxb.]	Garbadru ...	Bhábar.
12	Ichnocarpus frutescens	Dúdhi ...	Common.
	ORDER 19.—ASCLEPIADEÆ.		
	TRIBE PERIPLOCEÆ.		
1	Cryptolepis reticulata	Rui kosa ...	Up to 4,000 feet.
2	Periploca calophylla [Streptocaulon calophyllum, Wright.]	Dál bheugla,	Common.
	TRIBE ASCLEPIADEÆ.		
3	Vincetoxicum canescens [Cynanchum glaucum, Wall.]	...	Common.
4	„ montanum [V. kunawarense, Madden.]	...	Frequent.
5	Calotropis gigantea	Ak, madár ...	Common, Bhábar.
6	„ procera [Hamiltonii] ...	„ ...	Rare, Bhábar.
7	Cynanchum Dalhousiæ	...	Frequent.
	TRIBE STAPELIÆ.		
	SUB-TRIBE PERGULARIÆ.		
8	Tylophora tenerrima	...	Frequent.
9	„ Govanii [Iphisia Govaniana, Wight.]	...	...
10	Marsdenia Roylei	Murkila ..	Common.
11	„ lucida, Edgw. ..	Dúdhi ..	Frequent.
12	„ tenacissima	...	Up to 4,000 feet.
13	Pergularia pallida	Súrkila ...	Common, Bhábar.
14	Gongronema nepalense	...	Frequent on rocks.
	SUB-TRIBE CEROPEGIÆ.		
15	Orthanthera viminea	Chapkiya ...	Bhábar.
16	Hoya lanceolata	...	Common, Bhábar, and up to 7,000 feet.
17	Ceropegia longifolia	...	Rare.
18	„ Wallichii	...	Frequent.
19	„ gracilis, Edgw. ...	...	„

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 20.—LOGANIACEÆ.		
1	Gardneria ovata	Banjáhi ...	Frequent.
2	„ angustifolia	...	„
3	Buddleia crispa [paniculata, Roxb.]...	Dhiriya, bháti, dhaula.	Common.
4	„ asiatica [necma, Hamilton],	...	„
	ORDER 21.—GENTIANACEÆ.		
	TRIBE CHIRONIEÆ		
1	Exacum tetragonum	Uda, titkána,	Frequent, Bageswar.
	TRIBE CHLOREÆ.		
2	Pladera pusilla	...	Common.
3	Canscora diffusa [virgata, Roxb.] ...	...	Bhábar.
4	„ decussata	...	„
	TRIBE SWERTICEÆ.		
5	Gentiana (Chondrophyllum) pedicillata.	...	Common.
6	„ capitata	...	„
7	„ aprica	...	Bhábar.
8	„ decemfida	...	Common.
9	„ marginata	...	„
10	Ophelia paniculata	Chiretta Titkána.	Autumn annual.
11	„ purpurescens	„ ..	„ „
12	„ cordata	„ ...	„ „
13	„ var. floribus dilute roseis ...	...	W. Waterfield, Naini Tál.
14	„ (Agathotes) angustifolia ...	„ ...	Autumn annual.
15	„ „ chirata ...	„ ...	„ perennial.
16	„ „ alata ...	„ ...	„ annual.
17	Halenia elliptica	...	Above 10,000 feet.
18	Swertia cuneata	...	Rare.
19	„ cærulea	...	„
20	„ speciosa [perfoliata, Royle],	Simariya ...	Common, above 10,000 feet.
	ORDER 22.—BIGNONIACEÆ.		
1	Calosanthes indica	Pharkath ...	Bhábar.
2	Millingtonia hortensis [Bignonia suberosa, Roxb].	Nim chambeli	Introduced.
3	Stereospermum [Bignonia, Roxb.] suaveolens.	Pátal ...	Bhábar.
4	Amphicome arguta	...	Banks of Patálganga.
5	Tecoma undulata	...	Ganai valley. May.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 23.—PEDALIACEÆ.		
1	Martynia proboscidea [M. diandra, Madden].	...	Naturalized.
2	Sesamum indicum	Til ...	„
3	Pedalium murex.	Gokhru ...	Bhábar.
	ORDER 24.—CRYTANDRACEÆ.		
1	Lysionotus ternifolia [L. serrata, Don].	...	Common up to 4,000 feet.
2	Didymocarpus subalternans ..	...	Rare.
3	„ aromatica ...	..	Frequent.
4	„ (Acaules) macrophylla ...	Pathar laung,	Common.
5	„ pedicillata ...	...	Bhábar.
6	„ lanuginosa ...	. .	Common.
7	Chirita Edgeworthii	Sankh pushpa,	„
8	„ bifolia	„ ...	„
9	Rhynchoglossum obliquum [Wulfenia obliqua, Wall]	...	„ up to 6,000 feet.
10.	Platystemma violoides	...	Common.
11	Æschynanthus Perottetiana ...	...	Bhábar.
12	„ grandiflorus ...	...	Har silang. October.
13	Polyneuron dimidiata	...	Col. Davidson.
	ORDER 25.—POLEMONIACEÆ.		
1	Cyananthus lobata	...	Pindari, above 10,000 feet.
2	„ integra	...	Kedár 12,000 feet.
	ORDER 26.—CONVOLVULACEÆ.		
	TRIBE ARGYREIEÆ.		
1	Rivea ornata	...	Bhábar.
2	Argyreia speciosa	...	„
3	„ setosa	...	Sarju, bank near Kapkot, September.
4	„ capitata	...	...
	TRIBE CONVOLVULEÆ.		
5	Quamoclit vulgaris	...	Bhábar.
6	Batatas pentaphylla	...	„
7	Pharbitis Nil	Baunra ...	Very common.
	var. intergrifolia [cærulea, Roxb.]	„ ...	Common.
8	Calonyction speciosum ...	...	Bhábar
9	Ipomæa vitifolia	...	„
10	„ Pes-tigridis	...	„
11	„ Pilosa	...	Kota Dún.
12	„ *sp.* [hirsuta, Madden] ...	...	„

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 26.—CONVOLULACEÆ—(concluded).		
	TRIBE CONVOLVULEÆ—(concluded).		
13	Ipomœa sessiliflora [sphærocephalus, Roxb.]	...	Very common.
14	" chrysoides [muricata, Madden].	...	Bhábar.
15	Aniseia barlerioides	..	Kosi bank, Khairna.
16	Convolvulus pluricaulis . .	...	Bhábar
17	" arvensis [Malcolmi Roxb.]	...	Naini Tál, Mr. Waterfield.
18	Porana racemosa	Maseti ...	Common.
19	" paniculata	" ...	"
20	Evolvulus alsinoides [sericea, Madden],	...	Very common.
	TRIBE CUSCUTEÆ.		
21	Cuscuta reflexa [verrucosa] ..	Akash leguli,	Common
22	" macrantha [grandiflora, Wall].	" ...	Frequent.
	ORDER 27.—BORAGINACEÆ.		
	TRIBE CORDIEÆ.		
1	Gynaion vestitum	Pyú ...	Common up to 3,000 ft.
2	Cordia latifolia, Roxb ...	Boria ...	Bhábar variety.
3	" Myxa, Linn.	Kodah ...	Common.
	TRIBE EHRETIEÆ.		
4	Ehretia serrata	Pánya ...	Common, April
5	" lævis	Kodah ..	" Bhábar, March.
6	" viminea [Rhabdia sericea ... Madden].	...	" in river beds.
	TRIBE HELIOTROPEÆ.		
7	Heliotropium strigosum [brevifolium Wall].	...	Common.
	TRIBE BORAGEÆ		
	SUB-TRIBE ECHIEÆ.		
8	Macrotomia Benthami	...	Badrináth.
	SUB-TRIBE LITHOSPERMEÆ.		
9	Onosma echioides	...	Above 10,000 feet.
10	Myosotis pallens	...	" " Chaupatta.
11	" longiflora	...	" " "
12	Bothriospermum tenellum [Cynoglossum prostratum, Don].	...	Rare, Binsar.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 27.—BORAGINACEÆ—(concluded).		
	SUB-TRIBE CYNOGLOSSEÆ		
13	Eritrichium rotundifolium ..	...	Above 10,000 feet; rare.
14	Echinospermum glochidiatum [Cynoglossum uncinatum, Royle].	Kura ...	„ „ „
15	Cynoglossum furcatum ..	„ ...	Very common.
16	„ micranthum [canescens, Wall].	„ ...	„ „
17	„ glochidiatum .	„ ...	Frequent.
18	Trichodesma indicum ...	...	Common.
	ORDER 28. –SOLANACEÆ.		
	TRIBE SOLANEÆ.		
1	Lycopersicum esculentum ...	Wiláyati baigan.	Cultivated.
2	Solanum (Pachystemon) tuberosum...	Ahi ...	„
3	„ Roxburghii [rubrum] ...	Chhota ghiwain.	Common.
4	„ verbascifolium ...	Ushita ...	„
5	„ (Leptostemon) indicum ...	Kant kári ...	„
6	„ xanthocarpum ..	...	
	„ *var.* Jacquinii ...	...	„
	„ *var.* Schraderi [diffusum] ..	...	„
7	„ esculentum [melongena], ...	Baigan ...	Cultivated.
8	Capsicum frutescens	Lál mirch ...	„
9	Nicandra physaloides	...	Introduced.
10	Physalis peruviana	...	„
	TRIBE DATUREÆ.		
11	Datura Wallichii [ferox, Madden] ...	Kála dhatúra,	Valleys.
	„ *var.* double	...	Cultivated.
12	„ alba	Dhatúra ...	Very common.
	„ *var.* double	...	Cultivated.
	TRIBE NICOTIANEÆ.		
13	Nicotiana Tabacum	Tamáku ...	Cultivated.
14	Petunia Phœnicea	...	Introduced.
	ORDER 29.—SCROPHULARIACEÆ.		
	TRIBE ANTIRRHINIEÆ.		
1	Verbascum Thapsus	Ekalbir ...	Common.
2	Celsia coromandeliana	...	Rare, valleys.
3	Linaria ramosissima	...	Common.
4	„ incana	...	„
5	Antirrhinum orontium	...	„ May fields.
6	Scrophularia Edgeworthii ...	...	Above 12,000 feet.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 29.—SCROPHULARIACEÆ—(continued)		
	Tribe Antirrhiniæ—(concluded).		
7	Scrophularia polyantha	Gajalla	Common.
8	„ himalensis	„	„
9	„ obtusa (Madden)	„	Frequent.
10	Mimulus nepalensis	...	Common.
11	„ gracilis	...	Frequent.
12	Mazus surculosus	...	Common.
13	„ rugosus	...	„
14	Lindenbergia grandiflora	...	„
15	„ urticæfolia [Stemodia ruderalis, Wall].	...	Very common.
16	„ macrostachya	...	Rare.
17	Limnophila menthastrum	Jangli sonf	Common.
18	„ hypericifolia	„	„
19	Herpestis Monnieria	Jál ním	„
20	Torenia cordifolia	...	„
21	Vandellia crustacea [pedunculata, Madden].	...	„
22	„ nummularifolia	...	Very common. August.
23	Bonnaya brachiata	...	Frequent. September.
24	„ grandiflora	...	„
	Tribe Rhinantheæ.		
25	Hemiphragma heterophyllum	...	Common at 10,000 feet, Dákuri and Dyúritál.
26	Digitalis purpurea	...	Introduced.
27	Wulfenia Amherstiana [Pæderota Amherstiana, Wall].	...	Common near water above 8,000 feet.
28	Veronica (Beccabunga) himalensis [grandiflora, Wall].	...	Above 10,000 feet.
29	„ anagallis	...	Up to 5,000 feet.
30	„ punctata	...	„
31	„ (Chamædrys) deltigera	...	Common.
32	„ „ laxa	...	Above 11,000 feet.
	„ *var.* of V. chamædrys?	...	Kedarnáth.
33	„ (Omphalospora) biloba	...	Common at 5,000 feet. March.
34	„ „ Maddenii Edge.	...	„
35	„ „ agrestis	...	„
36	Buchnera hispida	...	„
37	Striga hirsuta	...	„
...	„ *var.* lutea	...	
38	„ euphrasioides	...	„
39	Leptorhabdos parviflora [Gerardia and Sopubia parviflora].	...	„
40	Sopubia trifida	...	Grassy slopes at 6,000 feet.
41	Centranthera hispida	...	Bageswar. Frequent.
...	„ *var.* nepalensis		
42	Euphrasia officinalis	...	Above 7,000 feet.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 29.—SCROPHULARIACEÆ—(concluded).		
	TRIBE RHINANTHEÆ – (concluded).		
43	Pedicularis (Cyclophyllum) pectinata.	...	Frequent.
44	„ „ porrecta,	..	„
...	„ [elegans, Madden] ..	..	„
45	„ (Siphonatus) megalantha.	..	Above 10,000 feet.
46	„ (Edentuol) carnosa ...	...	Common.
	ORDER 30.—OROBANCHEACEÆ.		
1	Phelipæa ægyptiaca ...	...	Rare.
2	Æginetia indica ...	...	Frequent, Bageswar.
	ORDER 31.—ACANTHACEÆ.		
	TRIBE THUNBERGIEÆ.		
1	Hexacentris coccinea ...	Kaljug ...	Bhábar and valleys. Winter.
	TRIBE HYGROPHILEÆ.		
2	Hemiadelphis polysperma ..	...	Bhábar.
	TRIBE RUELLIEÆ.		
3	Petalidium barlerioides ...	Bakruola ...	„
4	Hemigraphis latebrosa, [Ruellia latebrosa].	...	Common.
5	Æchmanthera Wallichii [gossypina, Madden].	Jaundela ...	Very common. From this bees make the best honey.
6	Goldfussia pentstemonoides ...	...	Frequent.
7	Strobilanthes auriculatus ...	Tilkapuri ...	Bhábar.
8	„ Wallichii ...	...	Above 10,000 feet.
9	„ attenuatus ...	Kapur nali ...	Common.
10	„ glutinosus ...	...	„
	TRIBE BARLERIEÆ.		
11	Barleria dichotoma ...	...	Frequent, September.
12	„ nepalensis ...	...	„
13	„ ciliata (rosea) ...	Sarp jiba ...	Common.
14	„ cristata ...	...	„
15	Lepidagathis hyalina ...	...	„
16	„ ustulata ...	...	About 4,000 feet.
17	„ cuspidata ...	...	Common.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 31.—ACANTHACEÆ—(concluded).		
	TRIBE JUSTICEÆ.		
18	Phlogacanthus thyrsiflorus ..	...	Bhábar and valleys. common. March
19	Eranthemum nervosum ...	...	Bhábar and up to 6,000 feet. May,
20	Rostellularia procumbens ...	..	Very common.
21	Adhatoda vasica [Justicia Adhatoda],	Bashang. Arús of plains.	Common.
22	Rungia parviflora ...	...	,,
23	Dicliptera Roxburghii ...	...	,, up to 5,000 feet.
24	Peristrophe speciosa ...	...	
25	,, bicalyculata ...	...	Bhábar.
26	Rhaphidospora ciliata ...	...	Rare, Vishnuganga.
	ORDER 32.—PHRYMACEÆ.		
1	Phryma leptostachya ...	...	Common in woods.
	ORDER 33.—VERBENACEÆ.		
	TRIBE VERBENEÆ.		
1	Verbena Bonariensis ...	...	Naturalized.
2	,, officinalis ...	...	Common.
3	Lippia (Zapania) nodiflora ...	...	Up to 4,500 feet.
4	Lantana alba [L. dubia, Royle Ill.]	.	,, 3,000 ,,
5	Gmelina arborea ...	Kumár ...	,, 2,000 ,,
	TRIBE VITEÆ.		
6	Caryopteris Wallichiana [Clerodendron odoratum, Madden.]	Mohini ...	Very common up to 6,000 feet. April,
7	Premna (Gumira) serratifolia [spinosa, Roxb.]	...	Bhábar.
8	,, (Premnos) mucronata ...	Agniún ...	,,
9	,, ,, barbata ...	...	Common.
10	,, ,, herbacea ...	...	Rare.
11	Callicarpa arborea, Roxb. ...	Ghiwali ...	Common.
12	,, macrophylla, Vahl ...	Daiya ...	Frequent, Sarju bank.
13	Clerodendron serratum ...	...	Common.
	,, var. ternifolium	...	,, Bageswar.
14	,, infortunatum ...	...	,,
15	,, siphonanthus ...	...	Bhábar.
16	Vitex negundo ...	Shiwáli ...	Bhábar and outer hills, April.
17	Holmskioldia sanguinea ...	Kubtuliya ...	Common, October.
	ORDER 34.—LABIATÆ.		
	TRIBE OCIMEÆ.		
1	Geniosporum strobiliferum ...	...	Banks of Sarju.
2	Orthosiphon rubicundus ...	...	Common.
3	,, virgatus ...	...	Banks of Kosi.
4	Plectranthus (Isodon) scrophularioides,	...	Frequent.
5	,, ,, Gerardianus...	...	,,
6	,, ,, striatus ...	...	Very common October.

DIVISION II.—MONOPETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 34.—LABIATÆ—(continued).		
	TRIBE OCIMEÆ—(concluded).		
7	Plectranthus (Isodon) Coetsa ...	...	Very common. Octr.
8	„ „ rugosus ...	...	Common up to 6,500 ft.
9	„ (Pyramidium) ternifolius,	...	„ low elevations.
10	„ (Coleoides) cordifolius ...	...	„
11	Coleus barbatus ...	Fiwal ...	Very common.
	TRIBE SATUREÆ.		
	SUB-TRIBE ELSHOLTZIEÆ.		
12	Pogostemon plectranthoides ...	Rudra ...	Common.
13	Dysophylla cruciata	...	„ in swamps.
14	Colebrookia oppositifolia ...	Dulshat ...	„
15	Elsholtzia flava	Bhangria ...	„ down to 5,000 feet.
16	„ polystachya	Bhangria ...	Very common.
17	„ incisa	Set bhangria.	Rare.
18	Elsholtzia pilosa	...	Frequent.
19	„ eriostachya... ...	...	Rare.
20	„ (Cyclostegia) strobilifera	...	Common.
	SUB-TRIBE MENTHEÆ.		
21	Perilla ocimoides	Bhangria ...	Cultivated, September.
22	Mentha viridis	Pudina ...	Naturalized.
23	„ Royleana	...	Rare. Near Bhím Tál.
	SUB-TRIBE THYMEÆ.		
24	Origanum normale? [vulgare?] ..	Ban tulsi ...	Very common, autumn.
25	Thymus serpyllum	„ ajwáin...	Common, except outer range.
	SUB-TRIBE MELISSEÆ.		
26	Micromeria biflora	...	Very common.
27	Calamintha (Clinopodium) repens ...	...	„
28	„ „ [Melissa, Maiden] umbrosa	...	June, under trees.
29	Hedeoma nepalensis	...	Frequent.
	TRIBE MONARDEÆ.		
30	Salvia (Drymosphace) glutinosa [hians, Royle.]	...	Frequent, outer range.
31	Salvia (Aethiopis) lanata ...	Gariya ...	Very common, March.
32	„ „ Moorcroftiana ...	...	Above 10,000 feet.
33	„ (Notiosphace) plebeia ...	...	Bhábar and valleys.
	TRIBE NEPETEÆ.		
34	Nepeta (Pycnonepeta) spicata, var.	...	Common, Binsar.
	„ „ elata, Royle ...	...	Yellow, morning, blue afternoon.
35	„ „ elliptica ...	...	Common, Binsar.
36	„ (Cataria) ruderalis ...	...	Frequent.
37	„ „ leucophylla ...	...	Common.
38	„ „ graciliflora ...	...	Bhábar.
39	„ (Macronepeta) Govaniana ...	...	Frequent.
40	Dracocephalum acanthoides ...	...	Níti.
41	Lallemantia Royleana	Bálangu ...	Rare.

DIVISION II.—MONOPETALÆ—(*concluded*).

No.	Scientific name.	Vernacular. name.	Note.
	ORDER 34.—LABIATÆ—(concluded).		
	TRIBE STACHYDEÆ.		
	SUB-TRIBE SCUTELLARIEÆ.		
42	Prunella vulgaris	...	Common, June, Binsar.
43	Scutellaria linearis	...	„ spring.
44	„ repens	...	„ spring and autumn.
45	„ angulosa [scandens, Don].	...	„ autumn.
	SUB-TRIBE MARRUBIEÆ.		
46	Craniotome versicolor	...	Very common.
	SUB-TRIBE LAMIEÆ.		
47	Anisomeles ovata	...	Common.
48	Colquhounia coccinea [vestita, Wall]	Bhilmora and angiriya.	„ at Naini Tál and Badrináth.
49	Stachys sericea	...	Common.
50	„ splendens	Bhainsia ajwáin.	Rare.
51	Leonurus pubescens	...	Common.
52	Lamium amplexicaule	...	„
53	„ petiolatum	Tit páti ...	„
54	Roylea elegans	Guma ...	Frequent.
55	Leucas [Hemistoma] urticæfolia ..	...	„
56	„ [Ortholeucas] lanata ...	...	Common.
57	„ „ mollissima ...	...	Rare.
58	„ [Plagiostoma] hyssopifolia,	...	Common.
59	„ „ aspera [cephalotes, Blume.]	...	„
60	Leonotis nepetæfolia		Bhábar & Haldwáni.
61	Phlomis lamiifolia	...	Rare.
	TRIBE AJUGEÆ.		
62	Teucrium Royleanum (*var.*) albidum.	...	Common, valleys.
63	„ quadrifarium ...	...	„
64	Ajuga lobata	...	Bhábar.
65	„ remota	...	Very common.
66	„ parviflora	...	High elevations.
67	„ bracteosa	...	Very common.
68	„ decumbens	...	Rare.
	ORDER 35.—PLUMBAGINACEÆ.		
69	Plumbago Zeylanica	...	Common.
	ORDER 36.—PLANTAGINACEÆ.		
1	Plantago (Polyneuron) major, *var.* asiatica.	Bár tang ...	Rare.
2	„ „ erosa, Don, [longiscapa, Jacq.]	Lohuriya ...	Very common.
3	„ „ lanceolata.	...	Rare.

DIVISION III.—APETALÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—PHYTOLACCACEÆ.		
1	Phytolacca, decandra, *var.* acinosa, ...	Jirrag ...	Cultivated up to 10,000 feet.
	ORDER 2.—CHENOPODIACEÆ.		
1	Beta vulgaris, *var.* Bengalensis, Roxb.,	Pálang ...	Cultivated.
2	Chenopodium album	Bhatuwa ...	Common.
3	„ (Ambrina) Botrys ...	...	„
	ORDER 3.—AMARANTACEÆ.		
	Tribe Celosieæ.		
1	Deeringia celosioides	Kála lohári...	Common.
2	Celosia argcutea	Sirali and ghogiya.	„
	Tribe Achyrantheæ.		
3	Amarantus caudatus	...	Gardens.
4	„ anardana [farinaceus] ...	Ramdána and chua.	Cultivation.
5	„ spinosus	...	Common.
6	Ærua scandens	Sáji ...	„
7	Achyranthes aspera.	...	Not known at Kew
8	„ species [bidentata ?], ...	...	
9	Cyathula tomentosa [Pupalia sequax,] Madden.	Jhat kuri ...	Very common.
10	„ capitata.	...	Rare.
	Tribe Gomphreneæ.		
11	Alternanthera nodiflora ...	Bhímráj ...	Common. Bhím Tál.
	ORDER 4.—Nyctaginaceæ.		
1	Bœrhaavia diffusa	...	Common.
2	Mirabilis Jalapa	...	Introduced.
	ORDER 5.—POLYGONACEÆ.		
	Tribe Terygocarpeæ.		
1	Rheum emodi	Dolu ...	Above 10,000 feet.
2	Oxyria elatior	...	„ 9,000 „
	Tribe Apterocarpeæ.		
3	Rumex (Lapalium) Wallihchii ...	...	Bhábar.
4	„ nepalensis	Haluniya ...	Common.
5	„ (Acetosa) hastutus ...	Almora ...	Very common.
6	Kœnigia monandra or islandica ...	...	Above 12,000 feet.
7	Polygenum (Avicularia) effusum [herniarioides.]	...	Common.
8	„ Roxburghii	...	Rare.
9	„ illecebroides	...	„

DIVISION III.—APETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 5.—POLYGONACEÆ—(concluded).		
	TRIBE APTEROCARPEÆ (concluded).		
10	Polygonum ciliosum	...	Rare.
11	„ cognatum	...	14,500 feet.
12	„ recumbens	...	Common. September.
13	„ (Persicaria) Hamiltonii [hispidum, Don.],	...	Frequent, Bhábar, November.
14	„ barbatum	...	Bhábar. Common.
15	„ Donii	...	Frequent.
16	„ Posumbu	...	Bhábar.
17	„ flaccidum[glabrum,Roxb.],	...	„
28	„ amphibium	...	Naini Tál lake.
19	„ lanigerum	...	Frequent.
20	„ scabrinervium ...	..	Naini Tál lake.
21	„ (Bistorta) viviparum [bulbiferum, Royle].	...	15,000 feet.
22	„ sphærostachyum ..	..	Very common.
23	„ amplexicaule ...	...	Common.
24	„ affine [Brunonis, Wall.],	..	At high elevations.
25	„ emodi	...	Rare.
26	(Didymocephalon) delicatulum ...	...	12,000 feet.
27	„ nummularifolium,	...	14,500 feet.
28	„ filicaule [ciliatum, Don].	...	Rare.
29	„ humile ...	...	„
30	„ perforatum [punctatum, Don].	...	„
31	„ nepalense ...	...	Common.
32	„ sphærocephalum,	...	Frequent.
33	„ capitatum [repens, Wall.],	...	Very common.
34	„ sinuatum ...	..	8,500 feet.
	„ (Corymbocephalon) chinense,	...	Very common.
35	„ (Echinocaulon) horridum ...	...	Bhim Tál.
36	„ (Tiniaria) convolvulus ...	...	Common.
37	„ pterocarpum	...	„
38	„ (Aconogonon) frondosum ...	...	7,500 feet.
39	„ polystachyum ...	...	12,000 feet.
40	„ Fagopyrum esculentum [vulgare, Madden].	Ogal ...	Cultivated,lower hills.
41	„ emarginatum ...	Púpaṛ ...	Higher hills.
42	„ cymosum [corymbosum Madden].	Ban-ogal ...	Common. The native names given by Royle are incorrect.
	ORDER 6.—LAURINEÆ.		
	SECTION EXINVOLUCRATÆ.		
1	Cinnamomum Tamala, *var.* albiflorum.	Tejpát, dálchini.	Common. February—May.
2	Phœbe lanceolata	San kanwal...	Bhábar and valleys, February—May.
3	„ pallida	Kanwal ...	Common.
4	„ paniculata ...	Kapua kanwal,	Bhábar and valleys.
5	Machilus odoratissimus	...	Common. March—August.

DIVISION III.—APETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 6.—LAURINEÆ—(concluded).		
	SECTION INVOLUCRATEÆ.		
7	Tetranthera laurifolia [apetala, Roxb., *var* Roxburghii].	Gar-bijur ...	Valleys. June.
8	„ monopetala ...	Katmara, singrao.	Common. April.
9	Litsæa lanuginosa	...	Rare.
10	„ consimilis [T. pallens, Don.].	Chirira and chirchira.	Common, interior of hills
11	Daphnidium pulcherrimum ...	...	Frequent.
	„ bifarium	...	„
	ORDER 7.—THYMELACEÆ.		
1	Daphne papyracea [D. cannabina, Wall.],	...	Common.
	„ *var*. purpurea	Barwa ...	
	„ „ alba	Set baruwa...	Used, for paper-making.
2	Wikstrœmia salicifolia [Daphne sericea, Madden]	Chamliya ...	Common, used for making inferior paper.
	ORDER 8.—ELÆAGNACEÆ.		
1	Hippophaë salicifolia	Dur chuk ...	Common above 10,000 feet.
2	Elæagnus parvifolia	Chiwain ...	Common.
3	„ latifolia [ferruginea, D.C.]	...	Bhábar.
	ORDER 9.—SANTALACEÆ.		
1	Osyris arborea, [nepalensis, Madden.],	Bákar dhárá,	Common.
2	Thesium himalense	...	Rare, Biñsar.
	ORDER 10.—ARISTOLOCHIACEÆ.		
1	Aristolochia saccata	...	Frequent ; about 7,000 feet.
	ORDER 11.—EUPHORBIACEÆ.		
	TRIBE PHYLLANTHEÆ.		
1	Andrachne cordifolia [Leptopus cordifolius, Decc].	...	Very common.
2	Antidesma diandra	Sarshoti ámli	Bhábar.
3	Phyllanthus (Hemiglochidion) nepalensis [Bradleia ovata, Wall. Glochidion bifaria, Royle].	Bair mao ... „ „ ...	... Very common.
4	„ velutinus	...	
5	„ (Emblica) Emblica ...	Amla ...	Frequent.
6	(Paraphyllanthus) urinaria ...	Sláhi ...	Common.
7	(Euphyllanthus) parvifolius ...	...	Frequent.
8	Putranjiva Roxburghii	Putrá jivá ...	Bhábar.
9	Securinega (Fluggea) obovata [Phyllanthus retusus, Wall].	Dháni ...	Common.
10	„ leucopyrus [Phyllanthus albicans, Wall].	Ainta ...	...
11	Bischoffia Zeylanica [Andrachne trifoliata, Roxb].	Korsa ...	...

DIVISION III.—APETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 11.—EUPHORBIACEÆ—(concluded).		
	TRIBE BRIDELIEÆ.		
12	**Bridelia stipularis ... ...**	...	Rare.
13	„ (Cluytia) montana ...	Karnaliya ...	Common.
14	„ retusa	Khaja ...	Up to 3,000 feet.
	TRIBE ACALYPHEÆ.		
15	**Trewia nudiflora ... ...**	Túmri ...	Bhábar.
16	**Mallotus philippinensis [Rottlera tinctoria].**	Ryáni ...	Very common.
17	**Ricinus communis ... ...**	Ind, rendi ...	Common.
18	**Homonoya riparia [Adelia, Madden],**	Kandágar ...	Frequent.
	TRIBE HIPPOMANEÆ.		
19	**Jotropha Curcas ... ...**	Safed ind ...	Naturalized, Bhábar.
20	**Baliospermum montanum [Crotonpolyandrum, Roxb.]**	...	Common, Sarju bank.
21	**Excæcaria (Triadica) sebifera ...**	...	Introduced.
22	„ (Falconeria) insignis ...	...	Common.
23	„ (Euexcæcaria) acerifolia [sapium, Madden, Stillingia himalayensis]	Phutkiya ...	Very common, Sarju bank.
	TRIBE EUPHORBIEÆ.		
24	**Euphorbia pentagona [Royleana] ...**	Sohund ...	Up to 6,000 feet.
25	„ angustifolia [dracunculoides, Roxb.]	Dúdhila and Mahábir.	Common up to 6,000 feet.
26	„ hirsuta [longifolia, Don.],	„	Above 6,000 feet (like Helioscopia).
27	„ peploides	...	Frequent.
28	„ pilulifera	...	Very common.
29	„ notoptera	...	Ganai valley.
30	„ hypericifolia	...	Col. Davidson.
31	„ thymifolia	...	„
32	„ pilosa	...	„
	ORDER 12.—DAPHNIPHYLLACEÆ.		
1	**Daphniphyllum himalense [Gyrandra laurina, Wall. Ilicineæ *sp.*, Royle.]**	Rakt chandan rakt angiiya.	Frequent. Used in marking the tika mark on forehead.
	ORDER 13.—BUXACEÆ.		
1	**Buxus sempervirens ... ...**	Papar ...	Milam and Wán.
2	**Sarcococca saligna Dec. [S. nepalensis, Royle].**	Sukat sing...	Common, high levels.
	ORDER 14.—CANNABINACEÆ.		
1	**Humulus lupulus ... ...**	...	Introduced.
2	**Cannabis sativa ... ...**	Bhang ...	Very common.

DIVISION III.—APETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 15.—ULMACEÆ.		
1	Ulmus Wallichiana [erosa, Roth	Chambar máya.	Frequent. Flowers precocious.
2	„ parvifolia [virgata, Roxb.]	„	Frequent. Flowers coetaneous.
3	Holoptelea integrifolia [Ulmus integrifolia, Roxb].	Kanju	Common.
4	Celtis australis [tetrandra,, Roxb]	Kharak	Very common and planted.
5	Sponia politoria [Celtis tetrandra, Wall ?]	Khaoi, khaikai.	Bhábar and valleys.
	ORDER 16.—MORACEÆ.		
1	Streblus asper [Trophis aspera	Rusa	Bhábar.
2	Plecospermum spinosum [Batis spinosa].	...	Rare.
3	Morus indica	Shahtút	Frequent.
4	„ lævigata	„	„
5	„ serrata	Kimu	Common. Dioecious.
6	Ficus indica	Bar	Valleys.
7	„ infectoria	Pákar	Bhábar
8	„ Tsiela	Kathbar	Planted.
9	„ religiosa	Pipal	Valleys.
10	„ cordifolia	Kabai pipal,	Common.
11	„ retusa [nitida]	...	Bhábar.
12	„ Carica	Anjír	Cultivated.
13	„ virgata	Beru	Very common.
14	„ parasitica	...	Bhábar.
15	„ scandens	...	Valleys.
16	„ trachycarpa	...	„
17	„ Cunia	Kunia	Common.
18	„ glomerata	Gular	Planted and banks of Kali.
19	„ macrophylla	Timla	Fruit eaten.
20	„ oppositifolia	Totmila	Common.
21	„ Luducca	Kabhila	„
22	„ laurifolia	Dudhila	„
23	„ ovata	Betuli	„
24	„ Chincha	Kiamira	„
25	„ saxatilis	...	„
26	„ laminosa	...	„
27	„ acuminata	...	Bhábar.
	ORDER 17.—ARTOCARPEÆ.		
1	Artocarpus Lakoocha	Dháo	Introduced.
2	Cudrania javanensis	Mándu	Bhábar.
	ORDER 18.—URTICACEÆ.		
	TRIBE URENEÆ.		
1	Urtica parviflora	Shishauna	Eaten; very common.
2	Girardinia heterophylla	Awa bichhu.	Very common.

DIVISION III.—APETALÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 18.—URTICACEÆ—(concluded).		
	TRIBE PROCRIDEÆ.		
3	Pilea scripta [goglado, Wall.] ...	...	Common; Naini Tál.
4	Lecanthus peduncularis	Saochála ...	Very common: July, August.
5	Elatostemma sessile [Procris punctata, Don].	„ ..	„
6	„ platyphyllum ..	Gargela ..	Common.
7	„ Stracheyanum ..	...	Rare
8	„ diversifolium ...	...	Common; August.
	TRIBE. BŒHMERIEÆ.		
9	Bœhmeria rugulosa [nervosa, Madden]	Geti ...	Common: dishes made of the wood.
10	„ macrophylla	Saochála gol ka	Common.
11	„ platyphylla, *var.* rotundifolia.	Gargela ...	„
12	Chamabaina squamigera ...	...	Bhábar.
13	Pouzolzia viminea [sanguinea] ...	...	Frequent.
14	Memorialis pentandra [Urtica pentandra, Roxb.	Jaiphal jari,	Common.
15	„ hirta	...	Frequent.
16	„ quinquenervis ..	...	„
17	Villebrunea frutescens, [Urtica frutescens, Madden]	Poi dhaula and kágahl.	Common.
18	Debregeasia longifolia	...	Rare.
19	„ bicolor [Bœhmeria salicifolia, Madden]	Tushyári ...	Very common; April.
20	Maoutia Puya, [Bœhmeria frutescens, Don.]	Phusar patta and dhaula-kágahl.	Common up to 4,000 feet: Bhim Tál and Bageswar
	ORDER 19.—PIPERACEÆ.		
1	Piper sylvaticum	Pippula múl,	Common; Bhábar and valleys.
2	Piperomia reflexa. [saxatilis, Madden].	„ ...	Very common on trees.
	ORDER 20. CORYLACEÆ.		
1	Carpinus faginea	Gish chamkharak.	Common.
2	„ viminea	„	„
3	Corylus lacera	Kapási, bhotiya badám.	Above 10,000 feet. Common, Joshimath.
4	Castanopsis tribuloides ...	Kátonj ...	Frequent.
5	Quercus incana	Bánj ...	Very common.

DIVISION III.—APETALÆ—(*concluded*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 20.—CORYLACEÆ—(concluded).		
6	Quercus lanata	Bianj ...	Frequent; Lariya kánta.
7	„ semicarpifolia	Karshu ...	Common, high elevations.
8	„ dilatata	Tilonj ...	Very common.
9	„ annulata	Phalyant ...	Common, valleys.
	ORDER 21.—JUGLANDACEÆ.		
1	Juglans regia	Akhrot, ákor	Common.
2	Engelhardtia Colebrookiana ...	Mao ...	„
	ORDER 22.—MYRICACEÆ.		
1	Myrica sapida	Kaiphal ...	Very common.
	ORDER 23.—BETULACEÆ.		
1	Betula Bhojpattra	Bhojpatra ...	Above 10,000 feet.
2	„ (Betulaster) acuminata ... [cylindrostachys]	Haoul ... Shnoul ...	„ 8,000 „ Common.
3	„ nitida ...	Pnya-uleah,	„
4	Alnus nepalensis	Udcah ...	Banks of all rivers.
	ORDER 24.—SALICACEÆ.		
1	Salix (Pleiandræ) tetrasperma ...	Gar-bains ...	Common near streams.
2	„ „ acmophylla [dealbata, Jacq.].	...	Frequent.
3	„ (Diandræ) babylonica ...	Majnun ...	Introduced.
4	„ „ Wallichiana ...	Bains ...	Common.
5	„ „ elegans] kumaonensis, Lindley].	...	Top of China.
6	„ „ daphnoides ...	...	Above 10,000 feet.
7	„ „ Lindleyana ...	...	„ „
8	Populus nigra [fastigiata] ...	...	Introduced.
9	„ ciliata ...	Gar pipal ...	Common.
	ORDER 25.—LORANTHACEÆ.		
1	Viscum stellatum, Don. ...	Bánda ...	Common on Pyrus.
2	„ (Aphylla) articulatum ...	Ditto ...	Common on Quercus incana and dilatata.
3	„ attenuatum	Ditto ...	Ditto.
4	Loranthus (Euloranthus) ligustrinus,	...	Frequent; June.
5	„ (Scurrula) pulverulentus,	...	Common; winter.
6	„ „ cordifolius ...	...	Rare; December.
7	„ „ vestitus ...	...	Frequent; winter.
8	„ (Pentamera) longiflorus [bicolor, Roxb.].	...	Common; spring.

DIVISION IV.—GYMNOSPERMÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—GNETACEÆ.		
1	Ephedra vulgaris [Gerardiana] ...	...	Above 10,000 feet; fruit edible.
	ORDER 2.—CONIFERÆ.		
1	Pinus longifolia ...	Chír, salla ...	Very common.
2	„ Gerardiana ...	...	Above 12,000 feet.
3	„ excelsa ...	Rái salla ...	„ 10,000 feet, Kanol, Painkhanda.
4	Abies Smithiana	Rágha ...	Above 10,000 feet.
5	„ Brunoniana [dumosa] ...	„	Rare; found by Captain Webb.
6	Picea Pindrow ...	„	Common above 10,000 feet.
7	„ Webbiana ...	„	„ „ 12,000 feet.
8	Cedrus Deodara ...	Diyár ...	Introduced.
	ORDER 3.—CUPRESSINEÆ.		
1	Cupressus torulosa ...	Sarai ...	Naini Tál and Joshimath.
2	„ sempervirens ...	...	Introduced.
3	Juniperus (Oxycedrus) communis, ...	Chichiya ..	Milam and Níti, 12,000 feet.
4	„ „ recurva ...	Bhedara ..	Rare.
	„ *var.* squamata	Bel bhedara,	Háni Páni, 8,000 feet.
5	„ (Sabina) excelsa ...	Padam ...	Milam, 12,000 feet.
6	„ „ Wallichiana ...	Bhedara ...	Milam and Níti.
	Var. squamosa, Madden	Bel bhedara,	Pindari, Painkhanda, Rikholi gudri. A kind of yeast is made from this plant.
	ORDER 4.—TAXACEÆ.		
1	Taxus baccata	Thuner ...	Common.
2	„ nucifera	...	Rare; only found by Royle.

DIVISION V.—ENDOGENÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—ZINGIBERACEÆ.		
1	Curcuma angustifolia ...	Ban haldi ...	Up to 6,000 feet ; May.
2	„ longa [kachoor, Royle] ...	Haldi ...	Cultivated up to 4,000 feet.
3	Hedychium spicatum ...	Kachúr-kachri.	Common.
4	„ coccineum ..		
5	„ villosum [Madden] ...	Rakt haldi ...	„
6	„ tenuiflorum Murdan Ali]	...	Rare, Piyúra.
7	„ coronarium [flavum, Madden].	... ...	„ Gardens.
8	Roscoea purpurea ...		
9	„ alpina ...	...	Common ; autumn.
10	„ lutea [gracilis] ...	...	„
11	„ elatior ...	...	
12	Zingiber capitatum ...	...	Dákuri bináyak.
13	„ ligulatum ...	...	Bhábar.
	„ *var.* chrysanthemum ...	...	„
14	„ cassumunar [elatum, Madden?].	... ...	Bhím Tál. Bhábar ; eaten by pigs.
15	„ officinale ...	Adrak ...	Cultivated.
16	Amomum subulatum ...	Ilaichi ...	Gardens.
17	Costus speciosus ...	...	Rare; valleys. Autumn.
18	Globba secunda ...	...	Bhábar.
	„ Orixensis ? ...	...	„
	ORDER 2.—MARANTACEÆ.		
1	Canna speciosa ...	Kiwára ...	Gardens.
	ORDER 3.—MUSACEÆ.		
1	Musa sapientum ...	...	Cultivated.
2	„ nepalensis ...	...	River banks, Askot to Dhárchúla.
	ORDER 4.—AMARYLLIDACEÆ.		
1	Crinum toxicarium ...	Chandar kanwal.	Common ; July.
2	„ species ...	...	Introduced.
	ORDER 5.—HYPOXIDACEÆ.		
1	Curculigo recurvata ...	Pitári ...	Bhím Tál.
2	„ orchioides ...	„	Common up to 6,400 feet.
3	Hypoxis minor ...	...	Very common.
	ORDER 6.—IRIDACEÆ.		
1	Pardanthus sinensis ...	Katár pata ...	Very common.
2	Iris nepalensis ...	Nil-kanwal	Common.
3	„ kumaonensis ...	...	„
4	„ decora ...	...	Frequent.
5	Tigridia pavonia ...	...	Introduced.

DIVISION V.—ENDOGENÆ—(*continued*).

No	Scientific name.	Vernacular name.	Note.
	ORDER 7.—HYDROCHARIDEÆ.		
1	Vallisneria spiralis ...	...	Bhim Tál.
2	Hydrilla verticillata ..	...	„
	ORDER 8.—ORCHIDACEÆ.		
	TRIBE MALAXIDEÆ (END.)		
	SUB-TRIBE PLEUROTHALLEÆ.		
1	Oberonia iridifolia	Bánda ...	Low elevations.
2	Microstylis Wallichii	...	Colonel Davidson.
3	Dienia cylindrostachys	...	Common, Binsar, China, August.
4	Liparis nepalensis	...	Lariya Kanta, Colonel Davidson. August.
5	Pholidota articulata	...	Common, April.
6	Cœlogyne nitida	...	Valleys.
7	„ praecox	...	Kotahgár. October.
8	„ ovalis	...	Binsar; common, May.
	SUB-TRIBE DENDROBIEÆ		
9	Eria convallarioides [Octomeria spicata].	Garar panja,	Common on oaks, June
10	Dendrobium alpestre	...	Frequent.
11	„ Pierardii [roseum ?] ...	...	Common, June.
	TRIBE EPIDENDREÆ (END.)		
12	Apaturia Smithiana	...	Bhábar.
13	Phaius albus	...	Very common near Bhím Tal, June.
14	„ bicolor	...	Colonel Davidson.
	TRIBE VANDEÆ.		
15	Cymbidium triste [Luisia trichorhiza.]	...	Frequent, low levels.
16	Eulophia campestris	...	Rare Bhábar. Salep made from root.
17	„ herbacea	...	Frequent, sweet scented.
18	Cyrtopera fusca (flava, Royle Ill.) ...	...	Common up to 4,500 feet. May.
19	Vanda cristata	Bánda ...	Common, on trees. June.
20	Saccolabium guttatum	...	Very common, low elevations. May, June.
21	„ papillosum [Cymbidium præmorsum, Roxb.],	...	Haldwani, on Ulmus integrifolia.
22	Aerides affine	...	Common. June.
23	„ odoratum [cornutum, Roxb.],	...	Colonel Davidson.
24	Calanthe plantaginea	Hyacinth orchis.	Very common. April.

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 8.—ORCHIDACEÆ—(concluded).		
	TRIBE OPHRYDEÆ.		
25	Orchis latifolia	...	Phulasain near Joshimath, June.
26	Aceras angustifolia	...	Very common.
27	Platanthera Susannæ	...	Ramgár, September.
28	„ obcordata	...	Near Naini Tal Brewery. September.
29	„ acuminata	...	Naini Tal. Colonel Davidson.
30	Hemipilia cordifolia	...	Near Khairna, September.
31	Peristylus goodyeroides	...	Frequent.
32	Herminium Monorchis	...	Top of Lariya Kánta, August.
33	„ gramineum	...	Rare.
34	Habenaria pectinata	...	Common, September.
35	„ intermedia	...	„ „
36	„ marginata	...	Very common, August, September.
37	„ ensifolia	...	Colonel Davidson.
38	„ plantaginea ...	...	„ „
39	„ rostrata, Madden ...	...	Perhaps same as emarginata. No. 36.
40	Gymnadenia commelynæfolia, Madden.	...	On Kálimath, 6,000 feet.
41	Satyrium nepalense	Pakwa-dimni,	Very common, August, September.
	TRIBE GASTRODIEÆ.		
42	Epipogium Gmelini	...	Colonel Davidson.
	TRIBE NEOTTIEÆ.		
43	Spiranthes australis	...	Very common, August, September.
44	Epipactis latifolia	...	Common.
45	„ macrostachya	...	„
46	Goodyera repens	...	„
47	„ procera	...	Binsar, August.
48	Zeuxine sulcata	...	Winter, Bhábar.
	TRIBE ARETHUSEÆ.		
49	Cephalanthera acuminata ...	...	Common, under trees, May.
	TRIBE CYPRIPEDIEÆ.		
50	Cypripedium cordigerum ...	...	Lariya Kánta, May. Colonel Davidson.

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 9.—PALMACEÆ.		
1	Chamærops Martiana	Thákil ...	Frequent.
	„ *var.* khasyana, Madden ..	„ ...	,
2	Wallichia densiflora [Harina oblongifolia.]	Kála-aunsa ..	Common, valleys.
3	Phœnix sylvestris *var.* humilis Madden.	Khajur ...	Up to 5,000 feet. Bisar.
4	„ acaulis	...	Bhábar.
5	Calamus Royleanus, [C. Rotang ?] ...	Bet ...	„
	ORDER 10. PONTEDERIACEÆ.		
1	Pontederia (Monochoria) hastata. [P. vaginalis, Madden.]	...	Common. Rice fields.
	ORDER 11.—MELANTHACEÆ.		
1	Disporum Pitsutum	...	Common.
2	„ Leschenaultianum [Uvularia Leschenaultii, Madden.]	...	„
3	„ Wallichii	...	Frequent.
4	„ Hamiltonianum ...	...	„
5	Iphigenia indica [Anguillaria indica, Brown.]	...	Common.
	ORDER 12. LILIACEÆ.		
	TRIBE. TULIPEÆ		
1	Tulipa stellata	Majaula, nalku,	Common up to 7,000.
2	Gagea elegans	...	„ above 10,000 feet
3	Lloydia serotina?	...	Common.
4	„ himalense	...	Above 10,000 feet.
5	Fritillaria verticillata	...	Phulsain, 8,000 feet.
6	„ Thomsonianum ..	...	Common, April.
7	Lilium Wallichianum	Findora	Common, Ránibagh.
8	„ nepalense	.	„
9	„ giganteum	Bhuniya nar,	Above 10,000 feet.
10	Methonica [Gloriosa] superba ...	Bish nángal,	Valleys.
11	Hemerocallis fulva [disticha] ...	...	Above 10,000 feet.
	TRIBE ALOINEÆ		
12	Aloe perfoliata	Ghikwár ...	Valleys, April.
13	Yucca gloriosa	Kámbáns ...	Naturalized.
	TRIBE HYACINTHEÆ.		
14	Uropetalum	...	Rare, Kálimath.
15	Urginea indica [Scilla indica, Madden].	Gesna ..	Common.
16	Allium leptophyllum	Piriya láhsan	Outer range.
17	„ Wallichii	Paderiya láhsan.	„
18	„ ellipticum	Sheolia láhsan ..	..
19	„ Jibba	Jibba ...	About 10,000 feet.
20	„ Argaud	Argand ...	Hánipáni, 8,000 feet.

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name	Vernacular name.	Note.
	ORDER 12.—LILIACEÆ (*concluded*).		
	TRIBE ASPARAGEÆ.		
21	Asparagus racemosus	Allora ...	Bhábar.
22	„ filicinus	Khairuwa ...	Common, edible.
23	„ adscendens	...	Common.
24	Polygonatum verticillatum ...	...	„
25	„ multiflorum	...	„
26	„ cirrhiflorum ? [Sibiricum ?]	...	„
27	Smilacina pallida	...	„
28	„ alpina	...	Kedár.
	TRIBE OPHIOPOGONEÆ.		
29	Ophiopogon intermedius ...	...	Frequent.
30	„ Wallichianus [spicatum, Madden].	...	Common
	ORDER 13.—COMMELYNACEÆ.		
	SECTION OLIGANDREÆ.		
1	Commelyna (Eucommelyna) salicifolia.	...	Frequent.
2	„ „ bengalensis ...	...	„
3	„ (Trithyro carpus) obliqua...	Kána ...	Very common.
4	Aneilema scapiflorum, [Murdannia scapiflora, Royle].	...	Common up to 4,000 ft.
5	„ lineolatum	...	Above 5,000 feet.
6	„ pratensum	...	Rare.
	SECTION HEXANDREÆ.		
7	Dithyrocarpus, paniculatus [rufus, Kunth].	Kandera ...	Common.
8	Cyanotis axillaris	...	Bhábar.
9	„ cristata	...	„
10	„ barbata	...	Common.
11	„ racemosa	...	Bhábar.
12	Streptolirion volubile	...	Rare.
	ORDER 14.—ALISMACEÆ.		
1	Sagittaria sagittifolia	...	...
	ORDER 15.—JUNCEÆ.		
1	Juncus bufonius	Shim ...	Common.
2	*„ glaucus	...	Frequent.
3	„ concinnus	...	„
4	„ Wallichianus	...	...
	ORDER 16.—SMILACEÆ.		
1	Smilax villandia, Royle ...	Kukar dhára.	Common.
2	„ macrophylla	„	Frequent.
3	„ aculeata	...	„
4	„ vaginata	...	Rare, China.

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 17.—DIOSCOREACEÆ.		
1	Dioscorea versicolor	Genti ...	Frequent.
2	„ sagittata	Tar tagur...	Tubers edible.
3	„ pentaphylla	Mugina muniya.	..
4			Tubers edible.
5	„ deltoidea	Gún ...	Above 6,000 feet.
	ORDER 18.—AROIDEÆ.		
	TRIBE DRACUNCULEÆ.		
1	Arisæma speciosum	Sarp ka goga,	Common.
2	„ Jacquemontii	„ ...	Very common.
3	„ costatum	„ ...	Common.
4	„ curvatum	„ ...	„
5	Arum hastatum	„ ...	Common, July.
6	Sauromatum guttatum	...	„
7	„ punctatum? ...	Kála bank ...	Káladhúngi.
8	Amorphophallus campanulatus [Arum campanulatum, Roxb.].	...	Bhábar.
9	Typhonium?	„ ...	Common, July, very fœtid.
	TRIBE CALADIEÆ.		
10	Remusatia vivipara	Baghpin lálu,	Up to 4,500 feet.
11	„ capillifera [Caladium pumilum, Don?	Bánj pindálu,	Above 5,000 feet, flowers, June.
12	Colocasia Roxburghii	Jungli gwia Gur pápar.	Very common.
13	„ himalensis	Gwia and pápar.	Cultivated.
	ORDER 19.—ORONIACEÆ.		
1	Acorus calamus	Bach bej ...	Rare.
2	Scindapsus officinalis, Pothos officinalis, Roxb]	Hathungliya,	Near Bhim Tál.
3	„ decursivus [Pothos decursivus].	Kelauniya ...	Binsar.
4	Pothos scandens	...	
	ORDER 20.—TYPHACEÆ.		
1	Typha elephantina	Padera, petára.	Bhábar.
2	„ angustifolia	Bora ...	Marshes.
	ORDER 21.—JUNCAGINACEÆ.		
1	Potamogeton natans	...	Bhim Tál and Naini Tál.
2	„ mucronatum ...	...	„ „
3	„ crispum	...	„ „
4	„ pectinatum ...	...	„ „
5	„ perfoliatum ...	...	„ „

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 22.—LEMNACEÆ.		
1	Lemna minor	...	Bhábar.
2	„ polyrhiza [orbiculata, Roxb.].	...	Streams, up to 4,000 feet.
	ORDER 23.—GRAMINEÆ.		
	TRIBE ORYZEÆ.		
1	Oryza sativa	Dhan ...	Cultivated.
	TRIBE PHALARIDEÆ.		
2	Zea Mays	Bhutta ...	Cultivated.
3	Coix Lacryma	Lakochiya ...	Common.
4	„ gigantea	„ ...	Frequent.
	TRIBE PANICEÆ.		
5	Paspalum longiflorum	Kána ...	Rice fields.
6	Panicum (Digitaria) cruciatum [Roylei, Madden.]	...	Frequent.
	„ *var.* distachyum	...	„
	„ octostachyum	...	„
7	Panicum (Orthopogon) acuminatissimum.		Colonel Davidson.
8	Panicum (Echinochloa) colonum ...	Jangli mandira.	Common.
9	„ frumentaceum ...	Jhangora and mandira.	Cultivated.
10	„ homonymum chamæraphis Madden].		Very common.
11	„ (Setaria) glaucum ...	...	„
12	„ Italicum	Kangni koni,	Cultivated.
13	„ (Virgaria) miliaceum ...	China ...	„
14	Pennisetum triflorum	Bimalsiya ...	Common.
15	Arundinella setosa [hirsuta, Madden]	...	„
16	„ nepalensis [miliaris, Madden,	...	„
17	Thysanolæna agrostis	Aunsa ...	Very common.
	TRIBE STIPACEÆ.		
18	Arachne (Piptatherum) holciformis,		Colonel Davidson.
19	Aristida cyanantha	Binniya & kakal una.	Very common.
	TRIBE AGROSTIDEÆ.		
20	Vilfa elongata [Sporobolus elongatus Madden].	...	Common.
21	Agrostis alba	...	Colonel Davidson.
22	Muhlenbergia sylvatica	...	Rare.
23	„ geniculata	...	„
24	Polypogon fugax	Gina gioliya,	Common.
25	Perotis latifolia	...	„
	TRIBE ARUNDINACEÆ.		
26	Phragmites Roxburghii	Bichra, nal...	Common
27	„ Karka	Karka „ ...	„
28	„ nepalensis	Nal tura ...	Bhim Tál.

DIVISION V.—ENDOGENÆ—(*continued*).

No	Scientific name.	Vernacular name.	Note.
	ORDER 23.—GRAMINEÆ—(continued).		
	TRIBE CHLORIDEÆ.		
29	Chloris decora	...	Common.
30	Cynodon dactylon	Dúb ...	Very common.
31	Eleusine coracana	Manduwa ...	Cultivated.
32	„ indica	...	Common.
	TRIBE AVENEÆ.		
33	Avena sativa	Jai ...	Cultivated,
34	„ fatua	Jai-ala ...	Common.
	TRIBE FESTUCEÆ.		
35	Poa annua	...	Introduced.
36	„ bulbosa	...	„
37	„ trivialis	..	„
38	Eragrostis cynosuroides ...	...	Common.
39	„ caudata	...	„
40	„ nutans	...	Col. Davidson.
41	„ amabilis	...	„
42	„ ciliata	...	Common.
43	„ plumosa	...	Very common.
44	„ diarrhena	...	Col. Davidson.
45	„ nardoides	...	Common.
46	„ orientalis	...	October.
47	Koeleria cristata	...	Very common, April.
48	Dactylis glomerata	...	Frequent.
49	Festuca (Brachypodium) nepalensis,	...	Common.
50	Tripogon (Plagiolytrum) filiforme,	...	„
	TRIBE BAMBUSEÆ.		
51	Arundinaria falcata	Ringál and Ningál.	Very common.
	(Two *varieties*)	...	...
52	Thamnocalamus spathiflorus ...	Ringál ...	Dúlatoli.
53	„ Falconeri ...	Káli ringál...	Common, May.
54	Dendrocalamus strictus ...	Báns ...	Bhábar.
55	„ *sp.* ...	„ ...	Dhanas; cultivated.
	TRIBE HORDEACEÆ.		
56	Lolium temulentum	...	Bhábar.
57	Triticum vulgare	Lál gehún ...	Cultivated.
58	„ striatum	...	Rare.
59	Hordeum hexastychum	Jao ...	Cultivated.
60	„ himalayense [cœleste] ...	Ua jao ...	„ above 10,000 ft.
	TRIBE ROTTBOELLIACEÆ.		
61	Ophiurus perforatus	...	Very common.
62	Rottboellia exaltata	...	Frequent.
63	„ hirsuta	...	Rare.
64	„ laevis [Mnesithia laevis],	...	„
65	Manisurus granularis	...	Frequent.

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 28.—GRAMINEÆ—(concluded).		
	TRIBE ANDROPOGONEÆ. ANDROPOGON, WITH NUMBER IN STEUDEL.		
66	Heteropogon contortus, 37 ...	Kumariya ...	Common.
67	„ polystachyus, 42 ...	„ ...	„
68	Ischæmum corollatus, 65 ...	Noniya ...	Frequent.
69	Ischæmonea speciosus, 132 ...	...	„
70	Spodiopogon involutus, 117 ...	...	„
71	Apocopis himalayensis, 168 ...	...	Rare.
72	Bathratherum lancifolius, 237 ...	...	Common.
73	„ micans, 239 ...	...	„
	TRIBE ANDROPOGONEÆ.		
74	Bathratherum submuticus 240 ...	...	Common.
75	Cymbopogon pachnodes, 297 ...	...	„
76	„ distans, 298 ...	...	„
77	„ versicolor, 301 ...	Piriya ...	Very common. Naini Tal
78	„ pendulus, 303 ...	...	Common.
79	„ Iwarankusa, 306 ...	Miriya ...	„
80	„ Martini, 309 ...	...	Bhábar.
81	„ flexuosus, 310 ...	Bujara... ...	Very common Almora.
82	Andropogon erythrocoleos, 341 ...	...	Common.
83	„ punctatus, 343 ...	Pagrimalsi...	Very common.
84	„ controversus, 349 ...	...	Very common, October.
85	„ montanus, 352 ...	...	Colonel Davidson.
86	Sorghum halepensis, 384 ...	...	Common.
87	Anatherum muricatus, 393 ...	Gandar, kaskas,	„
88	Chrysopogon cœruleus, 404 ...	Gweriya, parmal.	„
89	„ Trinii, 408 ...	...	Rare.
90	„ Royleanus, 425 ...	Salim ...	Common.
91	„ echinulatus 426 ...	„ ...	„
92	„ villosulus, 427 ...	...	...
93	„ glaucopsis, 429 ...	...	Rare.
94	„ subrepens, 430 ...	...	„
95	„ parvispica [Rhaphis microstachya,] 431 ...	Palkiya, chiraula	Very common.
96	Spodiopogon petiolaris, 443 ...	...	Common, Naini Tal, July.
97	Anthistiria arundinacea ...	Ulla, kanyur,	Bhábar and valleys.
98	„ anathera	Jyotish-mati,	Roots luminous.
99	Imperata arundinacea [cylindrica Lam],	Shiro ...	„
100	Saccharum spontaneum	Jhansh ...	„
101	„ Sara	Sarur ...	Bhábar.
102	„ semidecumbens ...	Tat, mora ...	„
103	„ exaltatum	...	„
104	„ Munja	Munj ...	„
105	Erianthus olivaceus, Edgw. ...	Kans ...	Common.
106	„ vulpinus, Edgw. ...	...	„
107	„ filifolium, Nees. ...	...	„
108	„ rufum, Nees.	...	„
109	„ rufipilum, Steud. ...	...	„
110	Leptatherum Royleanum ...	...	Rare.
111	Pollinia *sp.*	...	Frequent.
112	Eulalia japonica	...	„

DIVISION V.—ENDOGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 24.—CYPERACEÆ.		
	TRIBE CYPERECEÆ.		
1	Cyperus (Pycreus) capillaris ?	...	...
2	,, diaphanus ?	...	...
3	,, angulatus	...	...
4	,, alopecuroides ?	...	...
5	,, (Eucyperus) compressus	...	...
6	,, difformis	...	...
7	,, Iria	...	Common.
8	Cyperus niveus	...	Very common.
9	,, tegetiformis	Motha ...	Cultivated.
10	,, tenuiflorus	...	Common, August
11	,, rotundus [hexastachyos, Roxb.]	...	,,
12	,, obliquus	...	,,
13	,, pusillus [pygmæus, Retz.]	...	...
14	,, Wallichianus	...	...
15	,, fimbriatus	...	...
16	,, dilutus	...	Very common.
17	Mariscus cyperinus	Panmotha and nagarmotha.	Common.
18	Kyllingia monocephala	Nirbisi ...	,,
19	,, triceps	,, ...	,,
	TRIBE SCIRPEÆ.		
20	Abilgaardia monostachya	...	...
21	Eleocharis palustris	...	...
22	,, uniglumis	...	...
23	Eleogenus ovata	...	...
24	,, capitata	...	...
25	Scirpus juncoides [muticus]	...	...
26	,, lacustris	...	Bhím Tál.
27	,, affinis [maritimus]	...	...
28	Isolepis setacea	...	...
29	,, supina	...	...
30	,, Roylei	...	...
31	,, trifida	...	Common.
32	Fimbristylis pallescens	...	...
33	,, junciformis	...	Very common, August.
34	,, subtristachya [communis]	...	Common.
35	,, quinquangularis	...	,,
36	Eriophorum comosum	Bábar ...	Very common, autumn.
	TRIBE HYPOLYTREÆ.		
37	Lipocarpha argentea	...	Very common, July and August.

DIVISION V.—ENDOGENÆ—(*concluded*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 24.—CYPERACEÆ—(concluded).		
	TRIBE RHYNCOSPOREÆ.		
38	Rhynchospora chinensis	...	...
39	" Wallichiana	...	...
	TRIBE CARICINEÆ.		
40	Carex (Androgynæ) longipes	...	...
41	" foliosa	...	...
42	" nubigena	...	Common.
43	" notoleia	...	...
44	" Vahlii [alpina]	...	...
45	" hæmatostoma	...	...
46	" setigera	...	...
47	" myosurus	...	Above 5,000 feet, May.
48	" condensata	...	Common.
49	" filicina	..	"
50	" (Bifidæ) saxatilis [rigida, Good].	...	...
51	Carex notha	...	...
52	" acuta [gracilis, Curtis]	...	...
53	" (Trifidæ), ligulata	...	...
54	" cardiolepis	...	...
55	" Royleana	...	...
56	" Moorcroftii	...	...
57	" emodorum [alopecuroides Don],	...	...
58	" obscura	...	...
59	" fusiformis	...	...
60	" Wallichiana	...	...
61	" cruenta	...	...
62	" (Incertæ) Thomsonii, Boott.,	...	...
63	" mitis, Boott.	...	...
64	" uncinoides, Boott.	...	...
65	" vesiculosa, Boott.	...	...
66	Uncinia nepalensis	...	...
	ORDER 25.—ERIOCAULONEÆ.		
1	Eriocaulon sexangulare	...	Very common, swamps.
	ORDER 26.—TRILLIACEÆ.		
1	Paris polyphylla	...	Common.
2.	Trillium Govanianum, Royle	...	Kúlára Pass, 11,000 feet.

DIVISION VI.—ACROGENÆ.

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—FILICES.		
	TRIBE GLEICHENIACEÆ.		
1	Gleichenia dichotoma	...	Common.
	TRIBE DICKSONIEÆ.		
2	Woodsia lanosa	...	Rare, Dudatoli.
3	„ elongata	...	Common.
4	Dicksonia appendiculata [Sitolobium, J. Smith].	...	„
	TRIBE HYMENOPHYLLEÆ.		
5	Hymenophyllum polyanthus [exsertum ?]	...	On trees, Binsar, October. J. H. Batten.
	TRIBE DAVALLIEÆ.		
6	Davallia (Leucostegia) membranulosa,	...	Frequent.
7	„ „ immersa ...	...	„
8	„ „ multidentata? pulchra.?	...	Rare.
9	„ „ chaerophylla [cystopteris, D. C]	...	Common, Binsar.
10	„ „ nodosa [Acrophorus Presl.]	...	Rare.
11	„ (Endavallia) divaricata (elegans, Madden).	...	Very common.
12	„ (Microlepia) Hookeriana ..	...	Bhábar.
13	„ „ speluncæ ...	...	„
14	„ (Stenoloma) tenuifolia ...	...	Common.
	TRIBE PTERIDEÆ.		
15	Adiantum lunulatum	..	Common.
16	„ caudatum [rhizophorum Swartz].	...	Very common.
17	„ Capillus-veneris ...	Mubáraka ...	Common.
18	„ venustum	Hansráj ...	„
19	„ pedatum		„
20	Cheilanthes Dalhousiæ	...	„
21	„ farinosa [dealbata ...	...	Very common.
22	Onychium auratum	...	Common.
23	„ japonicum	...	„
24	Pellæa [Cheiloplecion] gracilis ...	...	Rare; resembles Cryptogramma crispa.
25	„ [Allosorus nitidula ...	...	Rare.
26	„ [Platyloma] calomelanos ...	Bish kutra...	On rocks at low levels.
27	Pteris (Eupteris) longifolia ...	...	Very common.
28	„ „ cretica ...	...	„ „
	„ „ var. stenophylla...	...	Common.
29	„ „ quadri aurita ...	...	Very common.
30	„ (Pæsia) aquilina ...	...	Very common.
31	„ (Campteria) biaurita ...	...	Rare.
32	„ „ Wallichiana ...	...	Common.
33	„ (Litobrochia) incisa ...	...	Near Ramghár, J. H. Batten.

DIVISION VI.—ACROGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—FILICES—(continued).		
	TRIBE BLECHNEÆ.		
34	Woodwardia radicans	...	Low levels, very common.
	TRIBE ASPLENIEÆ.		
35	Asplenium (Euasplenium) ensiforme.	...	Common. Binsar, July.
36	„ „ alternans	...	Very common on walls.
37	„ „ viride ...	...	Above 12,000 feet.
38	„ „ trichomanes	...	Common.
39	„ „ resectum ...	...	Frequent.
40	„ „ planicaule	...	Common.
41	„ „ adiantum nigrum.	...	Rare.
42	„ „ fontanum,	...	Frequent.
43	„ „ varians ...	...	„
44	„ „ bulbiferum,	...	Rare.
45	„ „ tenuifolium [concinnum Wall].	...	„
46	„ (Athyrium) thelypteroides.	...	Colonel Davidson.
47	„ „ macrocarpum [foliolosum Wall].	...	Common.
48	„ „ nigripes ...	...	Colonel Davidson.
49	„ „ filix femina [pectinatum].	...	Common.
50	„ „ oxyphyllum.	...	Colonel Davidson.
51	„ „ fimbriatum,	...	„
52	„ „ umbrosum [Allantodia australe]	...	Rare.
53	„ (Diplazium) polypodioides.	Lingra ...	Common.
54	„ „ maximum	„ ...	„ edible.
55	„ (Anisogonium esculentum.	...	„ not edible.
56	„ (Hemidictyum) Ceterach [Ceterach		Rare; Very like Asplenium alternans.
57	Actiniopteris radiata	Morpuchh ...	Common, walls, Srinagar.
	TRIBE ASPIDIEÆ.		
58	Aspidium (Polystichum) auriculatum,	...	Common.
59	„ „ ilicifolium...	..	„
60	„ „ Thomsoni ...	...	Above 8,000 feet.
61	„ „ aculeatum ...	...	Common.
...	„ „ var. rufo barbatum, Wall.	...	Very common.
62	„ „ Prescottianum,	...	Colonel Davidson.

DIVISION VI.—ACROGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER I.—FILICES—(continued).		
	TRIBE ASPIDIEÆ—(concluded).		
63	Aspidium (Polystichum) aristatum (coniifolium Wall).	...	Bhábar.
64	„ (Cyrtomium) falcatum ...	...	Frequent.
...	„ „ *var.* caryotidium.	...	Very common.
65	Nephrodium (Lastrea) patens ...	...	Colonel Davidson.
66	„ „ canum ...	...	„
67	„ „ prolixum ...	...	Common.
68	„ „ filix mas ...	...	Very common.
...	„ „ *var.* cochleatum.	...	Common.
69	„ „ flaccidum ...	...	„
70	„ „ spinulosum ...	...	Very common.
71	„ „ sparsum ...	...	Common.
72	„ „ odoratum (eriocarpum, H. K.)	Katra ...	Very common; edible.
73	„ „ angustifrons,	...	Frequent.
74	„ (Eunephrodium) unitum ...	...	„
75	„ „ cucullatum (unitum, Sieb.).	...	Bhábar.
76	„ „ aridum ...	...	Colonel Davidson.
77	„ „ molle ...	...	Frequent.
78	„ (Sagenia) polymorphum ...	Lingra ...	Up to 4,000 feet.
79	„ „ variolosum ...	..	Rare.
80	„ „ cicutarium ...	...	Common.
81	Nephrolepis cordifolia [tuberosa. H. K.]	...	Rare; Pipa kothi.
82	Oleandra neriiformis	...	Common.
83	„ Wallichii	...	„
	TRIBE POLYPODIEÆ.		
84	Polypodium (Phegopteris) erubescens.	..	Low elevations.
85	„ „ distans ...	...	Common.
86	„ (Goniopteris) urophyllum,	...	
87	„ „ proliferum,	...	Bhábar.
88	„ „ lineatum ...	...	Valleys.
89	„ „ multilineatum.	...	„
90	„ (Goniophlebium) amœnum,	...	Common.
91	„ „ lachnopus .	...	„
92	„ „ subauriculatum (argutum, Wall).	...	Frequent.
93	Polypodium (Niphobolus) adnascens,	...	Common.
94	„ „ lingua ...	...	„
95	„ „ stigmosum,	...	Valleys.
96	„ „ fissum ...	...	Common, June.
97	„ „ (flocculosum).	...	Rare.
98	„ (Phymatodes) lineare [Pleopeltis nuda].	...	Scented fern; very common on trees.
99	„ „ normale ...	...	Common.

DIVISION VI.—ACROGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 1.—FILICES—(concluded).		
	Tribe Polypodieæ—(concluded).		
100	Polypodium (Phymatodes) membranaceum.	...	Common.
101	,, ,, trifidum [oxylobum, Wall].	...	Frequent.
102	,, ,, malacodon,	...	Rare.
103	,, ,, ebenipes ...	...	,,
104	,, (Drynaria) propinquum,	...	Common.
105	,, ,, rivale ...	...	,,
106	,, ,, quercifolium ...	...	Bhábar.
107	,, ,, juglandifolium,	...	Common.
108	,, ,, himalayense [venustum, Wall].	...	Frequent.
	Tribe Grammitideæ.		
109	Gymnogramma (Leptogramma) Totta,	...	Colonel Davidson.
110	,, (Engymnogramma) vestita,	Mouse ear fern.	Pyúra and China.
111	,, ,, Andersoni,	...	About 13,000 feet.
112	,, ,, javanica...	...	Binsar. August.
113	,, (Selliguea) lanceolata,	...	Rare.
114	,, ,, involuta ...	...	Common.
115	Vittaria (Euvittaria) elongata ...	...	Binsar.
116	,, (Tœniopsis) scolopendrina ?	...	Binsar, June.
	Tribe Acrosticheæ.		
117	Acrostichum virens	...	Bhábar.
	,, *var.* deltigerum [Meniscium deltigerum, Wall].	...	,,
	Tribe Osmundaceæ.		
118	Osmunda Claytoniana [interupta] ...	...	Very common 10,000 feet Chaupatta.
119	,, regalis *var.* japonica ...	...	Rare Kháti 10,000 feet. May.
	Tribe Schizæaceæ.		
120	Schizæa digitata	...	Common.
121	Lygodium scandenale	Marora, bandhaniya.	Bhábar.
122	,, japonicum	,, ...	Common.
	Tribe Marattiaceæ.		
123	Angiopteris erecta	...	Rare.
	Tribe Ophioglossaceæ.		
124	Ophioglossum vulgatum ...	...	,,
125	Botrychium lunaria	...	Binsar.
126	,, daucifolium ...	...	Common.
127	,, virginianum ...	...	Very common.
	var. lanuginosum ...	...	Common.

DIVISION VI.—ACROGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 2—EQUISETACEÆ.		
1	Equisetum debile	...	Bhábar.
2	„ diffusum, Don [scoparium, Wall].	...	Hill streams.
	ORDER 3.—LYCOPODIACEÆ.		
1	Lycopodium tenellum ...	...	Very common.
2	„ setaceum ...	...	Raro.
3	„ circinatum ...	...	Frequent, 4,000 feet.
4	„ subulifolium ...	Tula muka ...	Common.
	ORDER 4.—MARSILIACEÆ.		
1	Marsilia quadrifolia	...	Bhábar.
	ORDER 5.—SALVINIACEÆ.		
1	Azolla pinnata	Tarái ...	Common in pools.
	ORDER 6.—CHARACEÆ.		
1	Chara verticillata	...	Naini Tál and Bhím Tál.
	ORDER 7.—BRYACEÆ.		
	TRIBE DICRANACEÆ.		
1	Leptotrichum inclinatum, Mitten.	...	Hoti.
2	„ molliculum, Mittin ...	...	Common.
3	„ himalayanum Mitten.	...	„
4	Dicranum himalayanum, Mitten ...	...	...
5	„ reflexifolium, Muller.	...	...
6	Didymodon laxifolius	...	...
	TRIBE LEUCOBRYACEÆ.		
7	Octoblepharum albidum ...	...	Bhábar.
	TRIBE TRICHOSTOMACEÆ.		
8	Tortula squarrosa	...	Common.
9	„ anomala	...	...
10	Anoectangium Roylei, Mitten ...	...	...
11	„ Thomsoni, Mitten ...	...	...
12	„ Strachcyanum, Mitten ...	...	...

DIVISION VI.—ACROGENÆ—(*continued*).

No.	Scientific name.	Vernacular name.	Note.
	ORDER 7.—BRYACEÆ—(continued).		
	TRIBE TRICHOSTOMACEÆ—(concluded).		
13	Hymenostylium aurantiacum, Mitten,	...	...
14	„ curvirostrum ...	...	...
15	Barbula vinealis	...	...
16	„ sub-pellucida, Mitten ...	...	...
17	„ gracilenta, Mitten ...	...	...
18	„ nigrescens, Mitten ...	...	...
19	Desmatodon Laureri	...	...
20	„ Wallichii	...	...
21	„ involutus	...	...
22	Encalypta ciliata	...	...
	TRIBE GRIMMIACEÆ.		
23	Grimmia apocarpa	...	Rocks, common.
24	„ (Rhacomitrium) subsecunda,	...	„ „
25	Glyphomitrium tortula, Mitten ...	...	...
	TRIBE ORTHOTRICHACEÆ		
26	Orthotrichum Hookeri	...	...
27	Macromitrium Moorcroftii ...	...	...
	TRIBE FUNARIACEÆ.		
28	Funaria hygrometrica ...	...	Very common, summer.
29	„ leptopoda	...	...
	TRIBE SPLACHNACEÆ.		
30	Tayloria indica	...	...
31	„ (Dissodon) tenella, Mitten,	...	October.
	TRIBE BARTRAMIACEÆ.		
32	Bartramia Halleriana ...	...	...
33	„ leptodonta ...	...	Near Ithyphylla.
34	„ subpellucida, Mitten ...	...	Resembles „
35	Philonotis Turneriana ...	...	Common.
36	„ falcata ...	...	„
	TRIBE BRYACEÆ.		
37	Mielichoferia himalayana ...	...	Pindari, 11,000 feet.
38	Webera elongata ...	...	...
39	Bryum filiforme, Mitten ...	...	...
40	„ argenteum ...	...	Very common.